AMERICAN MACHINIST

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Universal Cutter and Tool Grinder.

We present herewith engravings showing an improved grinder for milling cutters, reamers, flat surfaces, etc., the outline drawings (page 2) being designed to show methods of using the machine, while at the same time they show the construction of some of the fixtures and appliances which accompany it.

The head and the vertical slide to which the knee is fitted are cast in one piece, which is attached to the column, the latter being fitted up as a cupboard for the reception of tools and fixtures. The shelves and door are of wood.

The wheel spindle, besides the usual bearings located in the uprights of the head-stock, has a third bearing as close to the wheel as it can be placed, this bearing being within a sleeve which is supported rigidly by the head-stock and extends outward toward the wheel, as shown, thus greatly lessening the tendency of the wheel to spring away from the work, while at the same time securing the required reach from the vertical slide.

The spindle is of steel, hardened and ground, and runs in gun-iron boxes, dust-protected and made adjustable for wear. Spindle is hollow and has rammer for knocking wheel arbors out of the taper hole.

To the outer extremity of the sleeve is fitted a clamp collar which carries the tooth rest used in grinding milling cutters; this location of it making its adjustment very convenient, and keeping it always in the same position relative to the wheel after it is once adjusted. The tooth rest is hardened steel, and is divided into two parts, one of these acting as a spring pawl in passing from one tooth to the next.

The bearings and slides are so made as to exclude dust so far as practicable.

The upper slide can be set and clamped to move at any desired angle, and for convenience in operating there are two actuating shafts for this, which are placed at right angles to each other, and are squared so that either of them receives the same crank handle. Adjustable stops limit the motion of this table when desired.

Fig. 2 shows the machine as arranged for grinding the radial teeth of a straddle mill, the cutter being held upon a stud fixed in the table.

At Fig. 3 is shown the method of grinding the axial teeth or face of the same cutter, the fixture here used being so arranged that, with slight changes, it serves for a very wide range and variety of work.

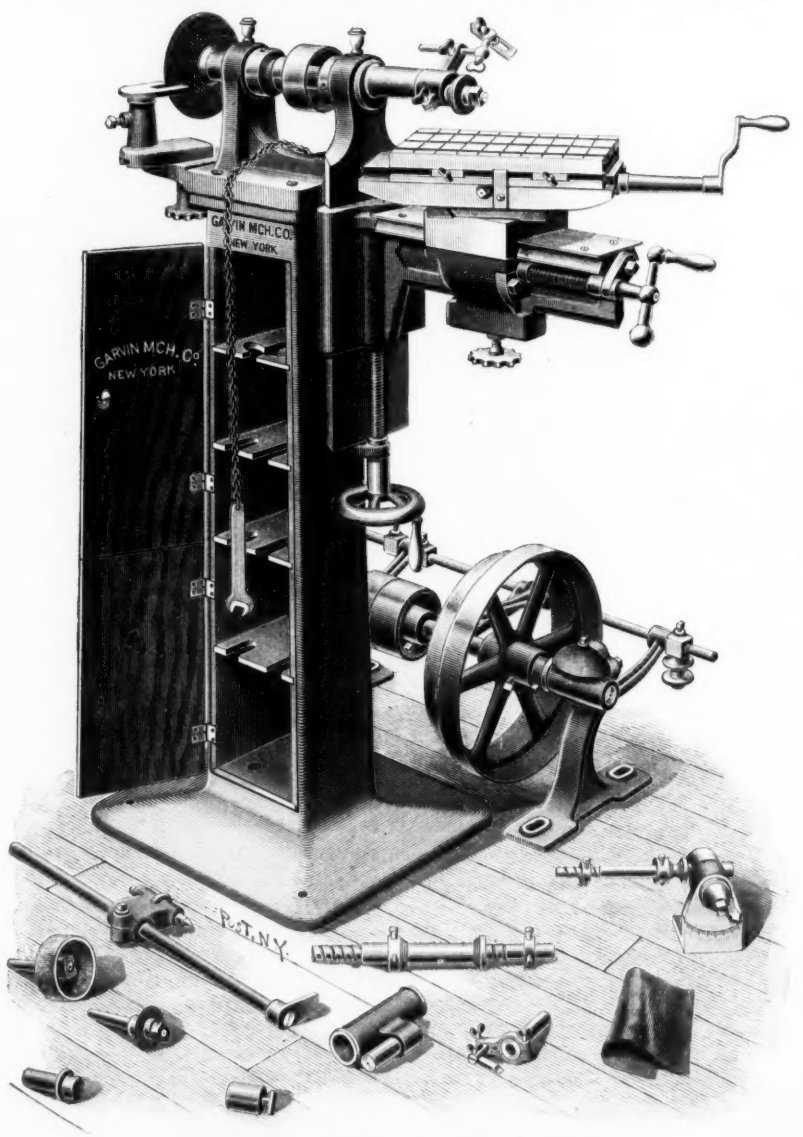
Fig. 4 shows it as arranged for grinding a spiral mill, for which work a sleeve that receives the cutter is arranged to slide upon the grooved cylindrical bar seen, and the arrangement here is such that this bar can be placed at any desired horizontal angle, so that the grinding may take place square across the cutting edges, or otherwise, as may be desired. It may also be placed at any desired angle vertically, the cutter being ground exactly the same diameter from end to end regardless of this.

For grinding angular cutters the arrangement is as seen in Fig. 5, where the graduations are used, as shown, for setting the stud at the desired angle.

At Fig. 6 is shown the same fixture provided with centers, the fixture being set upon the table at such an angle as to give the desired taper to the reamer, using a cup wheel for grinding.

Another way of grinding a taper reamer is shown at Fig. 7, in which a disk wheel is used and the centers are set at the required vertical angle. On these centers used in the same way, straight or taper taps can be sharpened by grinding, using the tooth rest.

At Fig. 8 is shown the method of grinding the radial teeth of a small butt mill, using a socket provided for that purpose, and a special tooth rest which is adjusted about the cutter holder much the same as the other rest is adjusted about the sleeve.



UNIVERSAL CUTTER AND TOOL GRINDER.

At Fig. 9 is seen in use a fixture for receiving the taper shanks of mill arbors, so that a gang of mills may be, when advisable, ground, or partially ground, without removing them from the arbor. A slight film of oil upon the shank of the arbor, allows it to turn freely in the fixture, and, as will readily be perceived, the arbor may be placed at any desired angle, from the vertical (as shown) to the horizontal, the latter position being that for grinding the axial teeth. The largest inserted tooth mills may be ground in the manner indicated in Fig. 2, and surface grinding, such as that required on the faces of dies and for snap gauges, may readily be done by holding the work in a vise placed upon the table, or in any special fixture. All the fixtures and appliances shown regularly accompany the machine, which is made by The Garvin Machine Company, Laight and Canal streets, New York.

Specific Heat.

BY PROFESSOR DEVOLSON WOOD.

We do not offer a new definition of specific heat, but will make some remarks about it that may lead to a more definite knowledge of it by those who have not made a thorough study of the subject.

If a pound of water be subjected to heat until its temperature is raised one degree on the thermometric scale, it is said to "absorb" a certain amount of heat. Whatever be the amount, it is taken as a unit—a standard. No way was known of determining that amount until Joule determined the so called "mechanical equivalent," when it was shown that the heat required to raise one pound of water one degree Fahrenheit was equivalent to raising 772 pounds of matter one foot; or, rather, according to the revised value, 778 pounds raised one foot. The heat required to raise one pound of any substance one degree is called the "specific heat." It requires more heat to do this under some circumstances than under others.

The specific heat of a gas or vapor is found by experiment when subjected to a constant pressure. The specific heat of air was first determined with approximate accuracy by computation, according to theory, by Rankine, who found it to be about 0.24. That is, it requires as much heat to raise one pound of air one degree as it does to raise 0.24 of a pound of water the same degree. Not long after this computation, Regnault, the celebrated French experimenter, determined the value to be 0.2375. This value was determined with the greatest accuracy, and has ever since been considered correct. The practical agreement of the computed and experimental value was considered a great triumph for the mechanical theory of heat.

The specific heat of a gas at *constant volume* has never been found by experiment. It is easy to conceive of ways by which it may be found, but so many elements enter the problem that cannot be accurately determined, that the result would not be accepted as reliable. Thus, if a box containing one pound of air—which would be about 12½ cubic feet—were heated to a known temperature, then immersed in a known weight of water and the rise of temperature of the water and the fall of temperature of the air be observed, the data will enable one to compute the specific heat of the air, the volume remaining constant—provided there be no escape of heat by radiation or absorption of heat by the vessel containing the water. But this method, or any equivalent one, is not used.

When the pressure is constant the volume of the air or gas will increase with increase of temperature, and external work will be done, and the heat absorbed not only makes the substance hotter but does external work. If the gas be perfect the heat which makes the pound hotter will be the same at all pressures and temperatures, and this is found to be true for all the so-called permanent gases.

Subtracting the external work expressed in thermal units from the specific heat at constant pressure, the remainder will be the specific heat at constant volume. The specific heat of air at constant volume is 0.1689, which, it will be seen, is less than that at constant pressure, as it should be.

In all cases, except for *perfect* gases at *constant volume*, the heat absorbed does other things than to make the substance hotter. We have already seen that it may do external work. When ice is changed to water at the freezing point, 32° F., no external work is done, neither is the temperature changed, and yet it has been found that sufficient heat must be absorbed to raise the temperature of the water thus formed 144° F. This amount of heat is necessary to break down the crystalline structure and reduce the ice to liquid water. It requires, then, 144 thermal units per pound of ice to produce this change. The equivalent in foot-pounds of work will be $144 \times 778 = 112{,}032$, which reduced to miles by dividing by 5,280, gives over 21 mile-pounds. That is, a pound of ice must fall more than 21 miles in a vacuum to produce sufficient mechanical energy, if all be transmuted into heat, to just melt it. This gives some idea of the immense silent

energy involved in either producing or melting ice. The specific heat being the heat absorbed by the pound of the substance divided by the increase of temperature, we have in this case 144 ÷ 0, which algebraically is infinite.

The energy in producing a pound of steam is still greater. At atmospheric pressure the boiling point of water is 212° F., and to change water at that temperature into steam at the same temperature requires 966 thermal units per pound. In this case the vapor will occupy 26 cubic feet, and external work will be done equal to $26 \times 2{,}116 = 55{,}016$ foot-pounds (2,116 is the pressure of the atmosphere on a square foot). The equivalent in thermal units will be $55{,}016 \div 778 = 70+$; hence, the thermal units required to break up the liquid form, and produce vapor at that temperature, will be $966 - 70 = 896$ thermal units. This is more than six times the energy necessary to change solid water to liquid. In almost all substances, some heat is involved in producing some molecular change in raising the temperature. Thus it is found that the specific heat of water is not the same at all temperatures. It decreases from 32° F. to about 70° or 80°, the exact temperature of the minimum value not being known, and then increases to 212° F.

Regnault, to whose experiments we look for the specific heat of most substances, so far as known, found it at atmospheric pressure only. Thus the specific heat of steam he found to be 0.48 at atmospheric pressure, and 1 once at 212° F., and in practice this value is assumed to be constant at all pressures and temperatures, but according to theory it ought to be less at higher temperatures, for as the temperature rises the steam ought to be more and more nearly like a perfect gas. If there be such a decrease, the law is not known.

In no other country in the world is the telephone in so general use as in Sweden.

Steamship Performance.

About two years ago a brief account was given in these columns—*Engineer*, page 11, January 1, 1892—of the gradual shortening in time of the Atlantic voyage, and a forecast was attempted of the probable efforts to cut down the time still more. At that time the crack vessels were the "Teutonic" and the "Majestic," the "Fürst Bismark," and the "Paris" and "New York"—at that time sailing under the British flag as the "City of Paris" and the "City of New York." Rumors only were afloat concerning two ships reported as ordered by the Cunard Company, and designed to outstrip the racers above named; but no official information as to size and expected speed was at that time procurable. The rumors, however, were not very far out, it seems, on the appearance of the "Campania" and "Lucania"; and these vessels have already been sufficiently long on their station for a fairly correct notion to be formed of their average performance, and superiority over all other competitors. In the first place, it will be noticed that this gain in speed, though apparently trifling on paper, say one knot, has only been secured by a very great increase in size and power; and that this increase has been strictly in accordance with Froude's Law of Similitude, as quoted in these columns. In popular language Froude's law may be stated thus: "One per cent. increase of speed over a given voyage—Queenstown to New York—requires 2 per cent. increase in length, 6 per cent. increase in displacement, and 7 per cent. increase in horse-power and daily consumption of fuel; though only 6 per cent. increase of fuel for the whole voyage." Thus, if an enlarged "Paris" is required to cross at 21 knots, an increase of 5 per cent. over the 20 knots of the present "Paris," 560 feet long, of 10,000 tons displacement and 20,000 horse-power, means that the enlarged vessel must be 10 per cent. longer, or 616 feet long. She must have 30 per cent. more displacement, or displace 13,000 tons; and have 35 per cent. more power, or 27,000 horse-power; and here we have as near as possible the dimensions of the "Campania" and "Lucania." The bunker capacity must be raised proportionately to the displacement, or from 2,500 tons to nearly 3,000 tons; but the coal shoveled daily must be raised from 300 to over 400 tons, and the stokehold complement proportionately increased. A higher pressure, too, must be carried—10 per cent. greater if the engines are to scale; but the boilers will have to be increased in size and number beyond the increase in geometrical scale, or the performance on trial will be a disappointment. But it will be urged that we are underestimating the speed of the vessel, as the record of the westward voyage is now nearly 5 days 6 hours, which, on a course of 2,772 miles from Queenstown to Sandy Hook, works out to a speed of exactly 22 knots. It is the fact, however, though generally suppressed, that these 5 days 6 hours, or 126 hours, are false hours—short-weight hours, although longer—because five hours have been deducted for difference of longitude. Adding these five

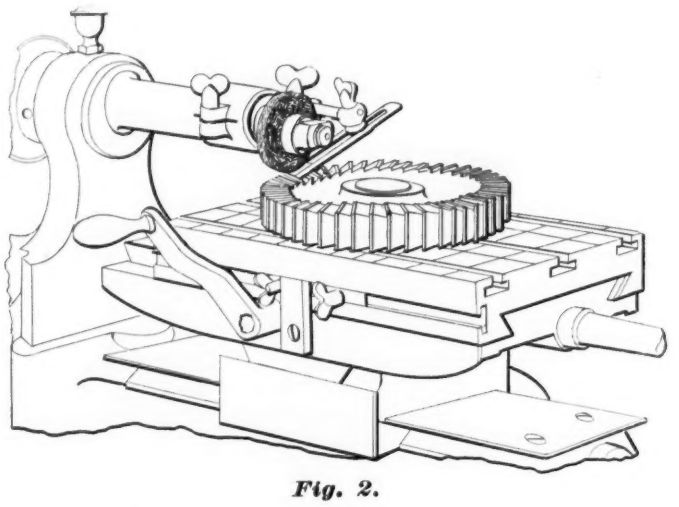


Fig. 2.

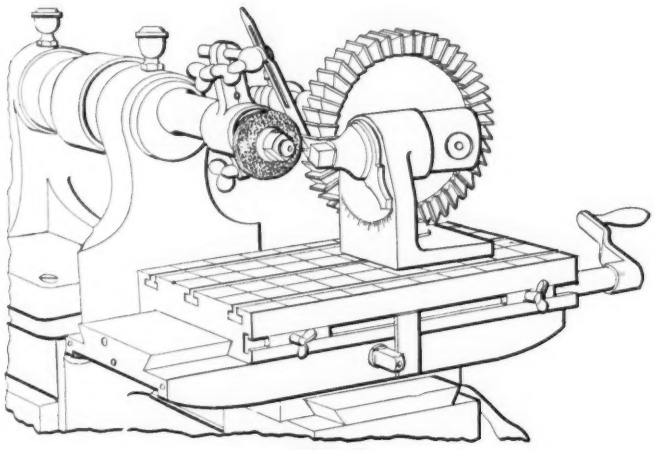


Fig. 3.

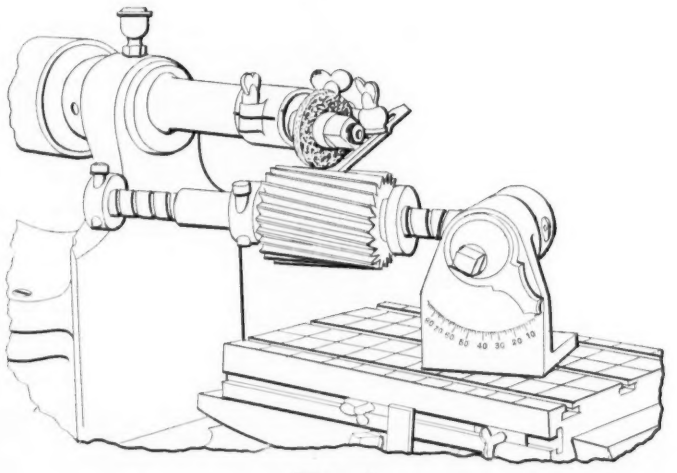


Fig. 4.

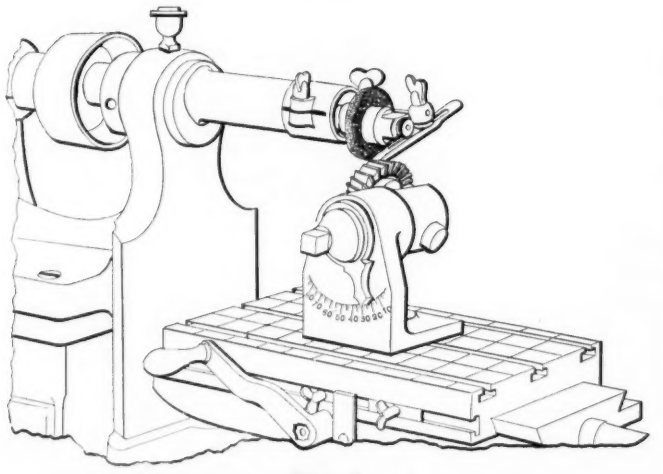


Fig. 5.

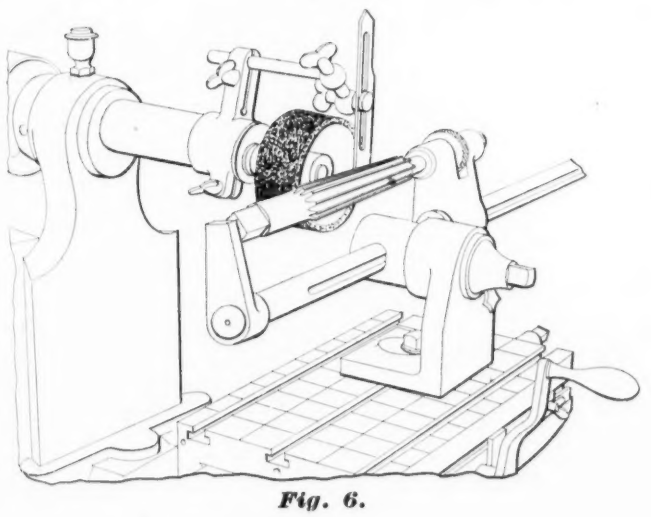
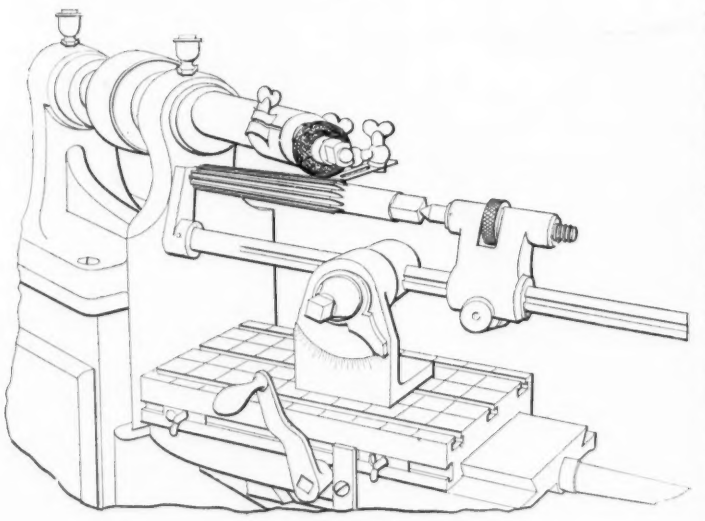


Fig. 6.



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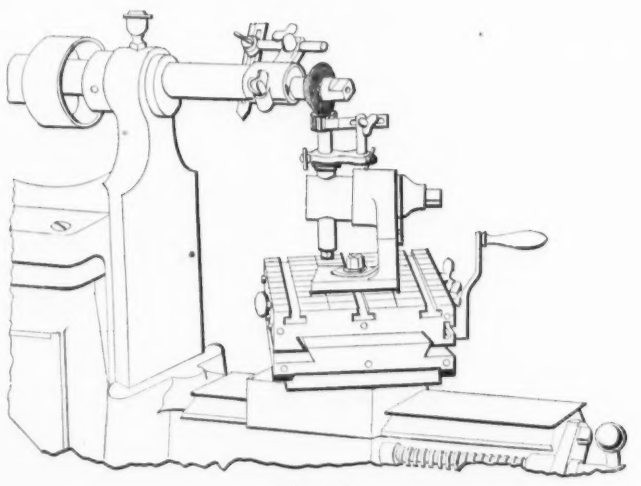


Fig. 8.

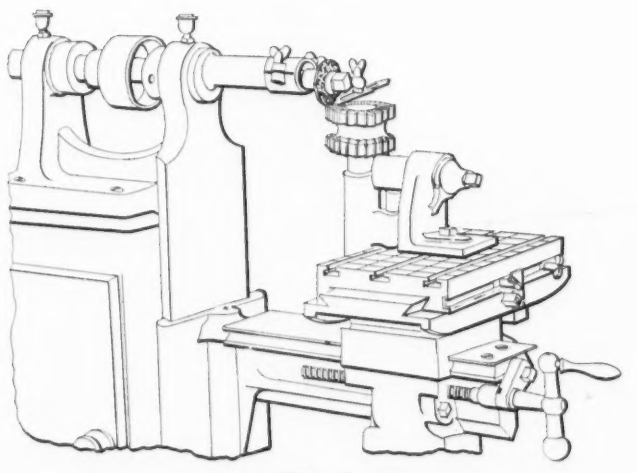


Fig. 9.

UNIVERSAL CUTTER AND TOOL GRINDER.—(See page 1.)

hours, 131 true hours have been occupied on the voyage, and the true speed through the water sinks to 2,772 ÷ 131, or 21.18 knots. A 21 knot vessel will occupy 132 true hours and 127 false hours, deducting five hours for difference of longitude, although four and a half is all that is allowable between Queenstown and Sandy Hook; so that the speed is jockeyed in this manner up to 21.83 knots.

The "clockers" of the record passages never add the five hours' longitude difference on the return eastward passage when the vessel is running against the sun, but allow themselves the "turn of the market." For this reason the times of the eastward passages are a better speed record, though here the advantage of a wind, which is generally favorable, is to be reckoned with.

While "clocking" in sport for the 100 yards, the quarter mile, the trotting mile, etc., has become so accurate that it is only surpassed by the electro ballistic apparatus at the proof butts, it still remains in the pre-scientific stage when it comes to deal with the speed of trains or steamers, even on the trial trip.

The apparent gain in speed on the westward voyage, due to running before the sun, becomes more and more important as the speed is increased. When the levitating aviator is perfected, which will cross the Atlantic at a speed of over 455 knots, the passage will be made in less than no time, on the above mode of reckoning; and for the matter of that, this is done already by the submarine cable. If the speed through the water is V knots, and the longitude difference is five hours over a voyage of 3,000 miles—Southampton to New York for instance—the true hours on the voyage are $\frac{3.000}{V}$, and therefore, $\frac{3,000}{V} - 5$ false hours; so that the apparent speed is $\frac{3,000\ V}{3,000 - 5\ V}$ knots, an apparent gain of $\frac{V^2}{600 - V}$ knots, or $\frac{V^2}{600}$ approximately.

Thus, if V is 24 knots, there is an apparent gain in speed of exactly one knot, and the voyage is apparently performed at a speed of 25 knots. The length in time of the voyage would be 125 true hours, as recorded by the chronometer, or the passengers' watches; but, taking advantage of the difference of longitude of five hours, this would be called a voyage of exactly five days.

But each day would be twenty-five hours long, as the passengers would find out by luncheon being a full hour late every day; and if the captain was anxious to seize a favorable opportunity of making a record day's run of over 600 miles, he would be tempted to keep luncheon waiting still longer before he declared that it was noon on the ship. If the five hours' difference of longitude were added on the return voyage, there would be an apparent loss in speed of $\frac{V^2}{600 + V}$ knots, or $\frac{V^2}{600}$ approximately. But whether the longitude difference is allowed for, as it is on the westward voyage, or neglected, as on the eastward voyage, an increase of speed of U on V knots will shorten the time of each voyage by the same number of hours, namely, 3,000 $U \div V^2$ minutes, on a course of 3,000 nautical miles. If ever Dr. Lardner's scheme of an express Atlantic service between Galway and Halifax should be revived, the reduction of the distance to about 2,000 miles, still with the same longitude difference of nearly five hours, would emphasize this apparent increase of speed, and lead to rather astonishing results of sustained sea speed.—*The Engineer* (London).

A Coming Flyer.

When in Wolverhampton a few days since, a *Machinery* correspondent was favored with a peep at the magnificent new locomotive being built in that town, and which, when complete, will rank as the fastest and most powerful in this country. The horse-power is 2,000, and the speed is to be 100 miles per hour; the driving wheels are 12 feet in diameter, and there are three cylinders of 40, 28, and 18 inches in diameter, with a 30″ stroke. The boiler pressure is 200 lbs. It is proposed to run from London to Edinburgh in six hours.—*Machinery* (London).

On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

Mr. Frank E. Wilder, of Salem, Mass., has contributed two solutions to Problem No. 5, the first of which, shown in Fig. 1, completely meets the conditions of the problem as stated. With reference to these solutions, Mr. Wilder writes:

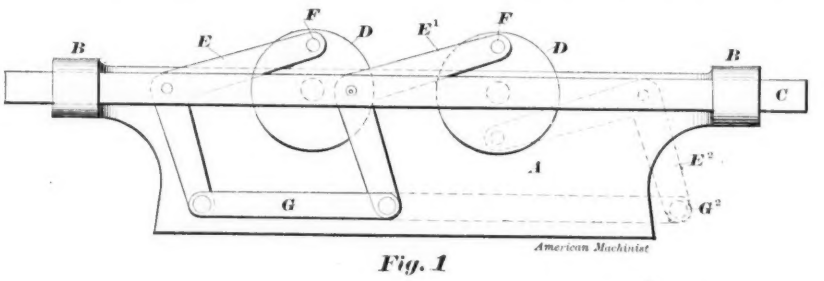


Fig. 1

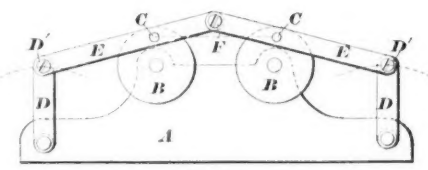


Fig. 2

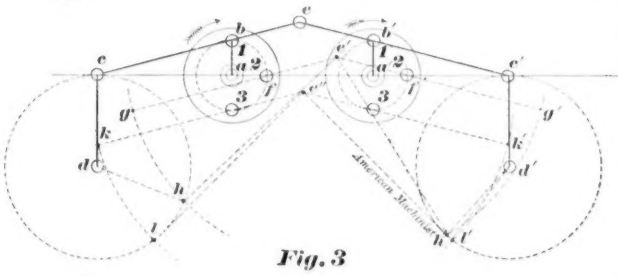


Fig. 3

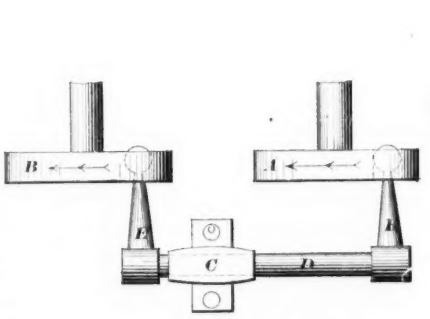


Fig. 4

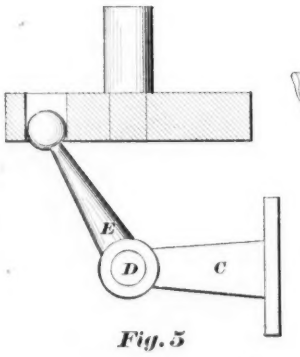


Fig. 5

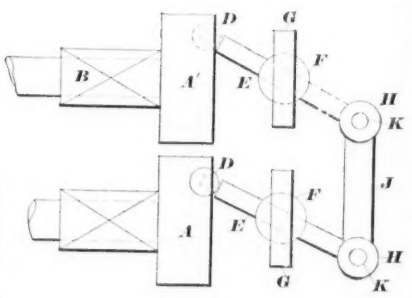


Fig. 6

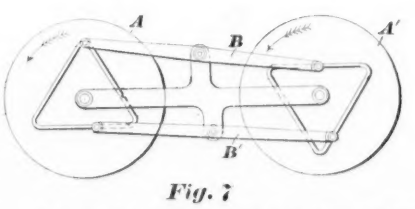


Fig. 7

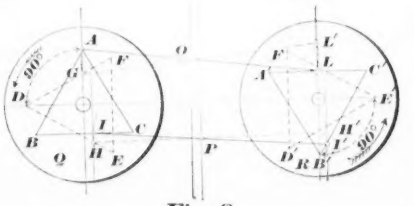


Fig. 8

"I herewith inclose two solutions of Mr. Leicester Allen's problem which appeared in the AMERICAN MACHINIST of April 13th.

"Referring to Fig. 1, A is the main frame, having proper bearings for the given disks D D and carrying the projecting ears B B. C is a flat bar sliding freely in the ears B B. E E' are two bell crank levers, occupying the space between the bar C and the disks D D. These levers are pivoted to the bar C and to the crank pins F F; and their lower ends are connected by the parallel bar G. Arranged in this way, it is obvious that the disks will rotate uniformly in either direction, and either one may be the driver; but if the lever E' be removed and placed in the dotted position E^2, and the bar G extended to it at G^2, then the disks will rotate in opposite directions, and either one may be the driver, as before.

"In Fig. 2, the main frame A is provided with suitable bearings for the disks B B and the two rocker arms D D. The disks are provided with crank pins C C. E E are connecting levers, pivoted to the rocker arms at D', to the crank-pins C, and their inner ends pivoted together at F. Sliding blocks might be used to receive the pivots D' D', but I think the rockers are preferable. With this movement, as with the other, the disks will rotate in either direction, and either one may be the driver, but so far as I have yet discovered, it is not capable of arrangement for driving the disks in opposite directions.

"Both these movements may be operated at a high speed, and both are pure lever movements without a hint of dead centers anywhere, and Fig. 2, in particular, I consider a very strong, reliable movement, and capable of driving much heavier work than the problem specifies.

"I consider Mr. Allen's articles a very interesting feature of the paper, and while the AMERICAN MACHINIST is always interesting, and I look forward to its coming with a great deal of pleasure, yet it is with an added sense of enjoyment that I sit down to its perusal when I find one of his articles in it. I hope to see them continued for some time. In conclusion, I should like to ask Mr. Allen if the solution of Mr. George W. Davis, in September 28th issue, is not a dangerous approach to a toothed gear, which was prohibited?"

In reply to the query of Mr. Wilder, I beg to say that the movement contributed by Mr. Davis, and that published in my previous article contributed by Mr. Gribben, have this important difference from what is ordinarily understood by toothed gearing, to wit, both of the movements transmit a motion to the driven wheel in the same direction as that of the motion of the driver; whereas, toothed gearing reverses motion.

It may, perhaps, be considered as exhibiting unpardonable vanity on my part to print the very flattering terms in which Mr. Wilder expresses his opinion of my work. But as this opinion is that of an accomplished mechanic whose name is well known in connection with the manufacture of fine machinery and machinists' tools, I feel that this testimonial to the value of these problems as an educational exercise is too valuable to be withheld through any feeling of delicacy prompting me to conceal it. Thanking Mr. Wilder for his complimentary language, I am compelled to criticise his second solution as not meeting the conditions of the problem, although it is an operative device which in strength and other good points may merit all that Mr. Wilder claims for it. The particular in which it fails is in the ratio of velocity imparted by the driver to the driven wheel, which, it appears, is variable; whereas, the problem requires that it should be constantly equal to 1. If I should be wrong in my analysis of this movement, I shall be most happy to have Mr. Wilder or any other reader show wherein my reasoning is at fault. As this solution is a type of quite a number which I have received, and as it is extremely plausible, I think it will be instructive to present my analysis of the movement. Several of my mechanical friends to whom I have submitted the solution have at once said that Mr. Wilder is right and that I am wrong. It is fair to these, however, to say that the analysis illustrated in Fig. 3, by which I have arrived at my conclusion, was not shown to them.

Referring now to Fig. 3, the positions of the rocker arms are indicated by the lines $c\ d$ and $c'\ d'$. The lines $a\ b$ and $a'\ b'$ represent the cranks in the position shown by Mr. Wilder, which position we will call the first position and number it 1 in the diagram. The position of the connected levers corresponding to this is indicated by the lines $c\ e$ and $e\ c'$. Let us suppose rotation to take place in the direction indicated by the arrows, and that the cranks take the second position numbered 2 in the diagram. Now it seems evident that if the crank-pins move with an equal velocity and their distance from center to center remains constant, the angle $b\ e\ b'$ included by the connected levers must be a constant for the positions 1 and 2, and for all intermediate positions. Constructing the same angle for the second position, we find that the two connected levers must in such case take the positions indicated by the dotted lines $g\ e'$ and $e'\ g'$. This would bring their extremities to the points $g\ g'$; but as these extremities are connected to the rocker arms turning on the centers $d\ d'$, it is impossible that they should take the positions indicated, as at all times these extremities must move in arcs described by extremities of the rocker arms. The positions of the extremities of the connected levers joined to the rocker arms, when the point e is changed to the position e', must be respectively at h and h', otherwise they would be somewhere out of the arcs described by the extremities of the croker arms, which, as we have seen, is impossible. But if the points h and h' be joined by dotted lines with e', neither of these lines will pass through the crank pin centers when the latter are in the second position. This proves that the point e cannot take the position e' when both the crank-pins are on the line $c\ c'$, and hence the crank-pin centers can never take the second positions at the same time, which they must do to have the required velocity ratio. A similar analysis for the position numbered 3 will show that the crank-pins can never assume positions at the lower center simultaneously. I have indicated this sufficiently in the diagram, and will not further dwell upon it. The actual positions which the parts would assume at various points during the rotation of the driver may be easily found by any one, and these would also show that the driven wheel would be given a variable velocity ratio by a uniform rotation of the driver. I do not discover that there is a dead point anywhere, hence I conclude that where an equality of velocity in the two disks is not essential this might be a useful movement. It illustrates how easily the mind may be confused in tracing out results of circular motion without recourse to a rigid geometrical test.

In Figs. 4 and 5 are shown a solution sent in by Mr. Alfred E. Johnson, of Carson, Nevada, which has the merit of great simplicity, and which, if properly designed, may, I think, be made to work very well.

It is certainly unique and ingenious. Mr. Johnson writes very modestly and somewhat deprecatingly of this solution, but I think a good mechanic might with confidence undertake to make a good movement on this principle. So far as I can see, the device meets all the essential requirements of the problem as given out. The disks *A* and *B* may either of them be driver or driven. They are bored at equal distances from the center to receive the spherical ends of the arms *E E*, which are secured at right angles to the shaft *D*, the shaft being adapted to slide and rotate in the stationary stand-box *C*. Fig. 2 is an end view showing the position of the arms at quarter revolution. Slides with ball and socket might be fitted to the ends of the arms *E*, and also fitted to play in the holes of the disks, and I think that such an arrangement could be made to work very well. The axes of the disks should be placed far enough apart to allow a liberal bearing in the stand-box.

A solution somewhat resembling Mr. Johnson's has been contributed by Mr. F. J. Curtis, of Pittsburgh, Pa. It satisfies the requirements, and is given herewith in Fig. 6. Mr. Curtis describes his device as follows:

"I inclose a rough sketch of my solution to your last problem. *A* and *A'* are the disks, either one of which may be the driver. In the face of each one of the wheels, near the rim, is located a ball bearing *D* Into these balls are fitted the arms *E*. These arms are round rods having flat tened eyes at their outer ends *H*. At *G G* are shown two bearings central with the axes of the disks. These are fitted with ball bearings *F*. These balls have holes through them to fit the arms *E* which are passed through the balls; and the flat eyes are connected with the flat link *I*, the pins *K K* being a working fit. When either disk starts to revolve, the other must follow in the same direction and at the same speed. There are no dead centers. The weak point in this device is the twisting strain on the link *I*. To get rid of this strain, where much power is to be used, I would suggest that the ends of the arms *E* be made balls instead of eyes, and the balls be fitted into sockets in the platen of a compound slide, the slide and platen being in an upright position."

It is sometimes even more profitable by way of instruction to work out a problem, the answer to which proves impossible conditions (that is to say, conditions which cannot exist simultaneously being incompatible) than it would be to work out one, the conditions of which can all be satisfied. If one wished to present such a problem, an attempted solution of my problem No. 5, contributed by Mr. Frank A. Risdon, of Waterbury, Conn., would furnish good material for it. This device is illustrated in Fig. 7. Mr. Risdon's description of his device follows:

"In this device either disk *A* or *A'* may be the driver. *B* and *B'* are levers which work on the plan of a walking beam. On both ends of each lever is a stud and roll which respectively work in the triangular slots in the faces of the disks. In order to avoid any dead center, one lever is placed off from the center. It will be seen that one of the levers is always in a position to keep the driven disk in motion. The support for the levers is a bar fitted to the ends of the shafts in front of the disks, thus bringing all the device on their faces, or in front of the disk."

Mr. Risdon modestly states in his letter that he is a novice in this kind of work, and I should have passed his solution by, merely remarking that it is inoperative, had I not seen in it a good opportunity to instruct him and other beginners in the art of testing such devices for themselves; and I do not lose sight of the primary purpose of these articles which was and is purely educational.

In general, to test whether any circular movement which may have been conceived to produce a given effect does produce it, one of the parts should be made to assume a position different from that in which it may appear to be operative. All the other parts must then be drawn in the positions they would correspondingly be compelled to assume. If they cannot take such positions there is an incompatibility somewhere in the conception. Illustrating this by Mr. Risdon's device, and referring to Fig. 8, I have made such an analysis of his movement as shows its inoperative character. Let me place it in the form of a problem to be solved which shall include one of the essential conditions of the problem No. 5, as announced by me, which condition was that each of the disks should move at all times with the same velocity as the other. The problem would then take the following form:

Two disks rotating in the same plane have two triangular grooves cut in their faces, the grooves being equal in every respect. It is now required to drive one of these disks from the other at the same velocity by two rigid rock-levers oscillating on their middle points, having their extremities supplied with rollers fitted to the grooves, and their centers of oscillation at *O* and *P* in the diagram, the initial positions of the parts being as shown in the diagram. To test the possibility of the solution of the problem thus announced, let us suppose the disk *Q* to be the driver and to be turned through an arc of 90 degrees in the direction indicated by the arrow. Then the driven disk *R* must be turned in the same direction through an equal arc in order to satisfy the condition of the problem that the velocity of the driven disk must at all times be equal to that of the driver. The angles of the cam groove in the driver will be respectively moved from *A* to *D*, from *B* to *E*, and from *C* to *F*. The angles of the cam groove in the driven disk will be respectively moved from *A'* to *D'*, from *B'* to *E'*, and from *C'* to *F'*. By construction, the rollers fitted to the ends of the rock levers must remain in the cam grooves. The roller at *A* in the driver must then be in the part *D F* of the cam groove when in the position shown by the dotted outline; and it must be also at the point *G* in the arc *A G* described around the center of oscillation *O*. Similarly, the roller *I* must be in the part *D E* of the cam groove of the driver when in the new position, and also in the arc described around the center *P* which would bring the roller to *H*. Now, as the rock levers are assumed to be rigid and to oscillate on their middle points, the opposite ends must respectively describe similar arcs, which would bring the roller originally at *L* to the position *L'*, and the roller originally at *I* to the position *H'*. But the points *H* and *L'* lie entirely outside of the cam groove of the driven wheel, which groove, if it move with the same velocity as the driver, would take the position *D' E' F'*. This being contrary to the hypothesis that the rollers must work in the cam grooves, proves the impossibility that the device can work as required by the terms of our test problem. I trust that I shall be able to reach a new problem in my next effort.

Concerning Boilers.

BY W. H. WAKEMAN.

In the ordinary tubular boiler, the shell consists of three or more sheets, according to size, and where these sheets lap over each other, it forms a double thickness of iron, and where this comes directly over the fire it is objectionable, because the lower sheet has the fire on one side, and only the iron of the upper sheet on the other. As this lap is usually a short one, no immediate damage results, but in the course of time leaks develop and the seams must be chipped and calked. This must be done repeatedly in some cases, until the lap is shortened so that it is not deemed expedient to continue it. To avoid this trouble, some boiler makers have sheets large enough so that but two of them are needed for the whole boiler —one on the top and the other on the bottom. This is a great improvement, for there are no rivets on the bottom to burn off on the outside, or to catch scale on the inside, and the boiler is stronger and better for it in every way.

Sometimes only one sheet is used on the bottom, and three or four on the top. This makes a good boiler, as the rivets are away from the fire; but we wish to ask a question along this line.

After a boiler maker has been to the expense of putting in machinery to handle these sheets, and the customer has agreed to pay an extra price for the boiler, why is it that the said boiler maker will put two braces on to the front head, under the tubes, and then bring the ends down and rivet them to the shell, directly over the fire? Where this is done, it makes two places where the sheet is exposed to intense heat on one side, and it is not in contact with water on the other, because the flat part of these braces prevents it. On referring this to a party who is interested in such matters, I was informed that it is better to put braces on in that way than it is to run them from head to head. As I like to understand the reasons for conclusions arrived at, I inquired for them in this case, and was informed that where braces are put on from head to head, even where the length does not exceed 16 feet, they are so long that it is hard work to get them tight.

Having had charge of boilers for more than 12 years that are braced in this way, and each time the annual inspection showing that "braces are sound and taut," I am convinced that even if it is not easy to get them tight as a rule, there are exceptions to it. If braces are made what might be called a trifle short, and then pins with tapering points are driven in to hold them in place, I think that they can be made tight every time, but if this cannot be done for any cause, then put a heavy turn-buckle in the brace and screw it up where it belongs.

In a certain case an engineer was sent to give directions concerning a boiler to be made, and as he was careful and competent it was expected that a good job would be the result. He could not give his whole time to it, and one day during his absence, they put in the braces from front head to shell, on the bottom. As he did not intend to have a single rivet exposed to the fire, he was chagrined, but when he found that they had not made correct calculations, and that as a consequence one of the braces had to be bent so as to pass under a tube, he was disgusted, for not only is a crooked brace of little value, but where it hits a tube they are both liable to be worn by motion caused by contraction and expansion, and as the tube is made of thin material, it will be worn quite through in the course of time. Where internal feed pipes are adopted, it is well to suspend them by chains from the braces and not allow them to rest on the tubes, for the same reason.

Of course, these braces under the tubes are a necessity where a manhole is in the front head (and I believe that there should always be one there), for although the tubes act as braces, and answer every purpose where they are near enough together, yet they are not sufficient to hold the space represented by the manhole and the additional space between it and the tubes. Experiments have demonstrated this to be a fact. Let us have them extend from head to head, with proper facilities for making and keeping them tight.

I note that the idea has been advanced that the age of boilers should be limited in every case, and the suggestion made that the limit be placed at 10 years. Our practice in many cases concerning the working age of boilers is certainly very lax, and it oftentimes approaches or reaches criminal carelessness, but to arbitrarily limit the age of all boilers to 10 years, would be going to the other extreme in some cases, and prove unjust and unreasonable. Such a law to be at all consistent must provide that all boilers must last 10 years, and this is an impossibility. Several devices have been invented to automatically regulate the supply of water to the boilers in factories and mills, but none of them are in general use, for the simple reason that intelligent supervision is superior to them in every way, and so it is with steam boilers for no law arbitrarily limiting their age will ever take the place of intelligent supervision. So long as boiler insurance companies will agree to forfeit a large sum of money if these boilers explode, and only charge a nominal sum for the guarantee, it will be hard work to convince our legislators that 10 years' limit law is necessary, and even if it were passed, it would not stand long, for the sight of scores of good sound boilers being taken out as having outlived their usefulness, would be too much for it and it would soon be repealed. I think that a law prohibiting the further use of condemned boilers would be a step in the right direction, providing it was rigidly enforced, for if a boiler is thrown out in one place, a few patches will be put upon it, a coat of black paint or asphaltum varnish added, and it will be sold and put into use where it must carry as high a pressure as it was required to when new. This is all wrong, but the practice will be continued so long as dealers in second-hand machinery are anxious to make money, and manufacturers are trying to save it, unless the law interferes.

In some cases boilers are examined by the agents of boiler insurance companies, and insurance denied on account of the unsafe condition of them, but they are continued in use, for the city or State inspector will issue a certificate stating that they are in good condition and safe under pressures varying from 50 to 80 pounds. If these boilers do explode they do not have to pay the bill, which makes a vast difference in all such matters. When boilers are purchased of reputable dealers only, pure water used in them, none but intelligent and competent engineers employed to run them, and their advice concerning them heeded, we shall not need a law of this kind.

According to the *Eisenbahn Zeitung*, Mr. G. Lentz, a locomotive constructor, said in an address before a German engineering society on locomotive design:

The German and other continental locomotives are modeled after both English and American designs, with the result that a mixture of the features of both is found in them, the practice of later years, however, following rather more closely the lines of English builders. But the inside cylinders and crank-axles of the English engine have not found favor, at least not in Germany, where sharper curves are permitted than in England, and where, therefore, numerous crank-axle failures have led to the adoption of outside cylinders. Compared with the English locomotive, the American engine does not commend itself in appearance to Mr. Lentz's tastes, there being, as he puts it, less beauty of design in its makeup, while in many cases it is embellished with flourishes and needless ornamentation which give it an unrestful air. The English builder, on the other hand, aims at the utmost simplicity, and turns out an engine solid and clean cut in appearance. Next to the English engines in the order of merit, so far as appearance is concerned, Mr. Lentz places those of Belgian make, in which inside cylinders largely prevail. Crank axle fractures, however, occur in large numbers with these, notwithstanding the fact that their design provides for an extra bearing for these axles.

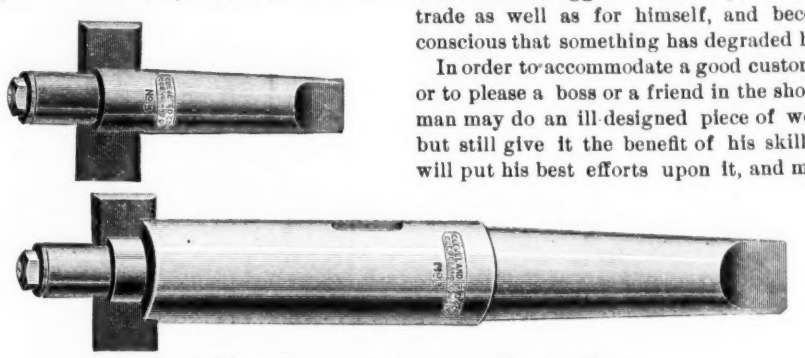
The effort to show that the trolley cars in Brooklyn were run at a speed greater than the regulation ten miles an hour was successful, 19½ miles being recorded in one instance.

The great London and Northwestern Railway Works, at Crewe, England, recently began working five days a week instead of four, at which they have been running. This favorably affects 7,000 workmen.

At a recent meeting of the Central Labor Union, of New Haven, Conn., letters were read from Senators Hawley and Platt and Representative Pigott, favoring federal acquisition of the telegraphs.

A New Counter-bore, and Facing Bar.

The counter-bore or facing bar illustrated consists of four pieces: The driver or socket, which is exactly like an ordinary drill socket, except that it has a slot across the open end to fit over and *drive* the blade. The cutter holder, which is a taper steel plug that will fit any modern drill socket or drill press. The cutter or blade, and a hardened steel bushing—the latter is turned to exact standard size, and is intended to fit the hole to be counter-bored or faced. The small screw shown in the cut has a conical point that fits a hole in the center of the blade, and its only duty is to center the blade; the bushings are held in place by the nut shown in the cut. As these bushings are split at their upper ends to fit the blades, there is no strain on this screw or nut; all the stress, both downward and torsional, is taken up by the larger socket or driver. These tools are made in four sizes, corresponding to the usual sizes of the taper shank drills, and are adapted to counter-bore holes from $\frac{3}{4}$" to 6", one of the latter size now being in constant use in a prominent Eastern shop. They are made by the Cleveland Twist Drill Co., of Cleveland, Ohio.

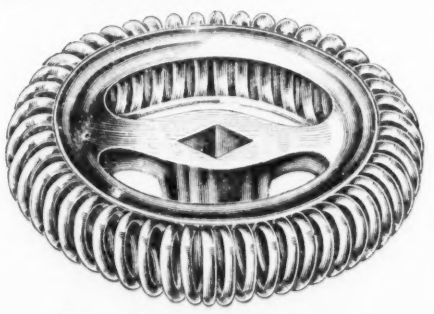


A NEW COUNTER-BORE, AND FACING BAR.

Zero Valve Wheel Handle.

We illustrate herewith an improved form of wheel handle for steam valves, the distinguishing feature of which is that though it is composed entirely of metal it will keep, not at the temperature indicated by its name it is true, but still cool enough to be comfortably handled under almost any condition met with, the free circulation of air around and through the helical spring, which forms the outer rim, keeping its temperature much below what it would be otherwise.

Each coil of the spring is securely fastened in place upon the malleable center and the wheel ought to prove very satisfactory in every way. It is made by W. F. Greene, 1931–1937 Sixth avenue, Troy, N. Y.



ZERO VALVE WHEEL HANDLE.

Items About Blacksmithing.

BY B. F. SPALDING.

A Boston blacksmith once innocentlyasked a bricklayer's helper who came into the shop, "What wages are laboring men generally getting now?" "I don't know," the disgruntled fellow replied with the hauteur of a Scotch bagpiper. "I can't say what is the pay of common laborers, but *mechanics* get from a dollar and a quarter to five dollars a day." The smith saw he had unintentionally stroked the feathers the wrong way and hastened to redeem himself. "Excuse me," said he, "it was my carelessness that I didn't see you are working at masonry." He heated his poker at the forge, and as a token of amity handed it to the pacified hod carrier, who lighted his tobacco and walked away with unruffled plumage, smoking the pipe of peace.

Probably in some of his skyward trips that man's head had struck the floating idea that the mechanic is one who deals with that kind of gross matter which is visible, or at least tangible, to such a degree that it may be impressed by physical force, and that the practical mechanic is one who uses any machine, whether of greater or less simplicity, to impart or direct motion.

The hod carrier did look down a little, however, on the common laborer who could only use the spade. Is that trait of our nature laughable? I reckon the humorists count it funny because I have seen an alleged comic picture which represents a street sweeper on a strike who is watching the "scab" who has taken his place, and saying: "Och! he may do well enough for plain swaping, but jest yez wait till it comes to a fine bit of dusting about a lamp post." Well, how much must any one know of the science of motion before he attains to such an eminence that self-conceit will not make him ridiculous? Professor Tyndal had his quiet kindly laugh at Count Rumford because he evinced some anxiety about his reputation when trying the initial experiments which claim to have demonstrated that heat is a form of energy. In view of the prominence of Professor Tyndal in connection with this subject it is singular that although these experiments are described and credited to Rumford in one of the "Modern Science Series," edited by Sir John Lubock ("Laws and Properties of Matter," by R. T. Glazebrook. D. Appleton & Co., 1893), yet among over fifty authorities cited and quoted from, the name of Professor Tyndal is not mentioned.

Mechanics who are employed in the shops are reminded by daily experience that the value of every kind of mechanical skill fluctuates with the occasions that call for its use. The finest gauge maker in the tool room can't get the boulder out of the water-main trench as readily as the mechanic of the pick and crowbar; the master mechanic himself is glad sometimes to find among his laborers an old salt whose ability to splice a rope can be made available on a momentous occasion, and on a cold winter morning the man with the pipe tongs is the hero of the hour. It is fortunate that one man can't know it all, every one has some share. It is this knowledge of the diversity of skill that creates a spirit of brotherhood among mechanics founded upon mutual dependence.

The rock upon which all mechanics build is the reality of things, their perception by the senses, and the immutability of physical laws. Hence, when a machine is given the required means, adequate means, there should be a certainty that he will do whatever he undertakes. If any one ought to be able to predict the result of his actions it should be the man who deals directly with material substance. That is the mechanic's advantage. He can reason from known causes to certain effects, and if the substance he operates upon has no invisible defects he need not fail to achieve the results he purposes. If he does not know what the effect will be when he brings a cause to act, when he strikes a blow, moves a lever, turns a wheel, or trips a spring, he is not working in the character of a skilled mechanic, trained in the art, but is either experimenting for information or blindly battering as a botch. There is a long distance between these two performances.

Every trade has its own technical tales. There is an old story, current among blacksmiths, about a fellow who was desperately hammering a chunk of hot iron on the anvil, which had never had an attack of the anvil principle, and consequently the melted metal was being scattered all over the shop, when an old farmer drove up, and thrusting his head in at the open door shouted, "Hullo there, what yer making?" The startled workman stopped short, stuck his iron back into the fire, shook the streaming sweat from his shaggy eyebrows, and said slowly and hesitatingly, "I der know yet whether it 'll be er hoe or er shovel. I'm tryin' ter make er nax." The reason this story has been adopted by the craft—and it was an old story when my father was a young man—is because it is a satire upon the unskillful blacksmith who has never learned the trade, but has set out to work at the business before he knew enough about it to be able to judge what will be the effect of the ordinary operations of blacksmithing.

Such a man is a botch. He will do a well-designed piece of work in an unworkmanlike manner. He is an unintentional botch who fails from incompetence. Not so is he who can do good work, but slights it, because he cannot get a price that will pay him for doing it well. He ought to belong to a trades' union that would amerce a fine on him if he becomes an intentional botch. If he is forced by indigent circumstances to do work which he knows is not good, he will after a struggle lose his respect for his trade as well as for himself, and become conscious that something has degraded him.

In order to accommodate a good customer, or to please a boss or a friend in the shop, a man may do an ill-designed piece of work, but still give it the benefit of his skill, he will put his best efforts upon it, and make it as good as he can though he feels that it is like hanging money on moonbeams, and if he had to stamp his name on the job he would not do it. The risk is too great; he risks his reputation which is his best capital.

Good work in all trades comprehends both good design and good execution. The British Admiralty discovered some fifty or sixty years ago that the anchors in use for the war vessels were proving very untrustworthy. They were breaking with alarming frequency entailing severe disasters. A thorough investigation into the manner of forging them and the details of their inspection was made, which resulted in the discovery that there was excessive hammering upon them at a black heat for the purpose of giving them a smooth, finished appearance. It was thought that at such a heat the surface-hammering produced a hard shell which was kept from contracting uniformly with the interior, and that the internal structure was weakened thereby. Experiments made with this in view seemed to justify the wisdom of the conclusion.

Blacksmithing may be well done and yet be far from being good blacksmithing. For instance, "a weld is a weld," we say, it is the uniting of the texture of two pieces of iron, but there are a variety of forms of welds, and there is always a chance that a weld may not shut perfectly and therefore a form of weld which might be admissible in one place might not be the best there and might be bad elsewhere. A butt-weld may not be out of place to weld ordinary shafting, but in shutting together oil drills which are liable to break deep in the ground it seems to be the generally received opinion that a tongue, or bear's mouth, weld is to be preferred.

There are but a few different things to do in blacksmithing. The major operations are to unite, to separate, to lengthen or shorten, to narrow or widen, and to cut or bend, masses or bars of wrought iron, or steel, or to force certain portions of these metals into dies, and cause them to receive the shapes of the contained impressions. There are a great many different ways of performing all of these simple operations, and a thorough acquaintance with these methods, and a judgment taught by experience constitutes a general knowledge of what science there is connected with the practice of blacksmithing. Experience dictates which method of performing any of the general operations should be adopted in any particular case.

Methods which accomplish the same results are so many and various, and there is such diversity of conclusion reached by different men from the same premises, that it is not likely that any two men would agree upon the best way of doing every kind of work; nothing will decide the question but the actual test of experiment. Some would be for making a piece of work out of the solid; others for welding it; some for welding in one place, and others in another. Some would drop forge a piece of work just the other end foremost from the plan adopted by another; or in work on the horizontal bending machine, the very bend that it seems essential to one person should be made first, will be the last one made by another designer who will give incontrovertible reasons for his opinion. Experiment will not decide the matter if the daily production is equal, and the workmen, if the piece is heavy, when asked if they think the other plan would be easier will answer: "Yes! any other plan but this."

The old Springfield musket had a bulge on the butt of the barrel for a cone seat. The barrel was iron. When steel barrels came to be used on breech loaders some of them had projections at the breech somewhat similar in the forging to the old cone seats, and the judgment of some of the old welders was that these should also be welded on, but the work coming into the hands of blacksmiths more accustomed to working steel, their opinion was that the course of safety would be not to heat the steel to a welding heat, and they adopted the plan of upsetting the end of the barrel, and working the projection out of the solid. This way avoided the risks of welding and proved to be equally economical.

As fact is the foundation upon which the mechanic must build, it is necessary for him to ascertain definitely and exactly what is fact. He may learn this from the experience of others or from his own. In the first case he has acquired science, in the latter he has gained experience. After he has tried both of these means of gaining information in practical application he will be apt to repose the greatest confidence in what he finds out for himself. It fits him better and clings closer to him, and he can lay his hand upon it at any moment with scarcely a conscious effort of memory. It has become a part of his identical self. He knows all the circumstances of his own experiments and can better judge of the bearing each of them has upon the result.

The blacksmith learns from others that the tensile strength of a certain iron is a specified number of pounds to the square inch, but he finds out for himself how much this strength is increased ordecreased by the circumstances of heating, cooling and hammering it, and he knows that steel is much more sensitive and variable in its nature, and that therefore whatever influence these circumstances may have upon iron it will be intensified and subject to much greater and less certain variations when it acts upon steel. Where is his solid rock of fact to be found now? Only in this that he has learned that no general testing of one piece as a sample of any number of others will give satisfactory assurance of the quality of any of the others. His solid rock is to be found in testing every piece of importance by itself, and trusting it no farther than it is proved. In doing this he is only conforming himself to the present prevailing practice among other mechanics, and the nature of his work requires as great precautions.

The blacksmith's tests are crude but crucial. The critical inspection which the practical blacksmith gives to every forging at the very time when it is in the best condition to expose its defects, combined with a judgment ripened by experience in repairing and careful studying of the scrap heap, generally stand him in good stead of a more ostensible test.

There are those peculiarities about irons which are distinguished as "red short" and "cold short," which make it difficult to decide what their behavior will be at any temperature except that at which they are worked; but when anything occurs which raises any suspicion about them, the smith's

anvil and hammer amply supply the place of more extensive testing machinery and enable him to ascertain quickly and with considerable accuracy whether these peculiarities will mar their usefulness in the duty they are expected to perform. He may apply a remedy, if he has one, or make such disposition of them as expediency suggests. "Red short" iron is the safest to use, as its defect is most apparent while it is being forged. If it passes this ordeal without sign of fracture it is fit for service. If it has a crack it will be liable to show itself in cooling. It will not part with its heat evenly on account of the severance of the fiber which conducts the heat. For the same reason it will show a crack while it is being heated; one part will heat before the other. Cold shuts are discoverable in the same manner.

It is safe to say that if a blacksmith cannot find any flaw in such work as is usually done on a common anvil, it will hide none which will injure it. But this cannot be affirmed of larger masses.

The testing of large pieces, and the fracture of massive iron is considered by Professor Thurston in Part II. "Materials of Engineering," and some very interesting instances are graphically shown.

Among others is the fractured surface of the connecting rod of the great testing machine at the Washington Navy Yard, which after being in use for thirty-five years, broke with a stress of 100 tons, although it had shortly before sustained a stress of 144 tons, and its figured strength was 400 tons. This unexpected giving out is like the wrestler, whose firm ankle could be trusted to throw an Orlando, but who gets it permanently disabled when he steps on a rolling broomstick in the back yard.

These failures are not always so sudden. I present a letter from a blacksmith in Springfield, Mass., illustrating the effects of fatigue on iron. I thought I remembered that the "T. B. Wales" and the "Addison Gilmore," two locomotives which ran into Springfield between 1850 and 1855, had wrought-iron driving wheels 8 feet in diameter; the letter replies to my inquiries. The date is May 14, 1884.

. . . "Now about the 'Gilmore': About 30 years ago I worked at the Boston & Albany Railway shops here in Springfield. There was a man there by the name of Jack Norton, an Englishman. He commenced making driving wheels of wrought-iron. He made the spokes with a piece for part of the hub. I think he got them all blocked out and left—went on a spree. Chase came to be boss about that time. I think Jack got as far as he could go with the things he had to do with. He wanted more pay and they would not give it to him. (My recollection is that he was getting $5 and wanted $10 per day.) The rest of the large welds had to be made as he had begun them. The company sent all the work that was done on them to Nashua, N. H., and they came back, a set of seven-foot driving wheels. Seven foot was the largest wheels I ever saw. They were put on the road, I think, 12 years, and then condemned, taken to the yard, and broken up. A man told me that where every weld was he could see the weld opening. The running shook them all to pieces. They were the last wrought-iron driving wheels that have been made in this vicinity.

JOHN S. ROGERS."

We are informed by Professor Weil, head of the mechanical department of Michigan Agricultural College, that the shops of that institution have been recently enlarged, the working capacity of the blacksmith and pattern shop having been increased and a new foundry built. In the foundry a No. 1 Colliau cupola has been placed. A 50 horse-power automatic engine built by the students has been added to the plant, and many other changes have been made.

One concern in Newark, N. J., is said to have made 160,000,000 corkscrews last year.

LETTERS FROM PRACTICAL MEN.

Automatic vs. Throttling Cut-off Engines.

Editor American Machinist:

I have read your editorial of January 25th, on "Throttling *vs.* Automatic Cut-off Engines," with considerable interest, and although agreeing with your conclusions to a certain extent it would seem to me that the real reason for the great success of the automatic cut-off in earlier years was as follows:

When Corliss valve gears were first used the pressures employed were generally low, and the gain, when the power was reduced by increased expansions, exceeded greatly the losses from the relatively increased radiation, increased conduction and considerably increased initial condensation, when compared with the other methods of reducing the power by throttling.

Again, the engines in which the automatic gear was first fitted were capable of taking the low pressure steam throughout nearly the whole length of their stroke, when the full load occasionally came on. The comparison was, therefore, between a throttling engine hardly expanding at all at full load, and consequently using very low-pressure steam when running at light loads, and using this steam almost inexpansively, and an engine doing its ordinary load at a cut-off giving probably three or four expansions. It could hardly be expected under such circumstances that a throttling engine could give results at all approaching the automatic cut-off engine. As pressures increased, however, it was found necessary to resort to compounding to get the full economy possible, and now an entirely different set of conditions are before us. Two or three cylinders in series are now used, and the ratio of expansion approaches more and more nearly by the use of two or three cylinders to that (sooner or later reached in all engines) beyond which there is no improvement in economy. It is clear, therefore, that the economic value of automatic expansion must necessarily become less and less as higher pressures and more expansions (cylinders) are used.

The late Mr. Willans, in his last paper before the Institute of Civil Engineers, England, has shown plainly that in the case of his own engine, "the Willans Central Valve," the above reasoning is corroborated by actual experimental results.

The writer, who carried out the whole series of experiments under Mr. Willans' direction, found that in the case of an engine working comparatively non expansively, at full load, as in the ordinary simple engine, the gain by altering the cut-off for lighter loads, rather than throttling to reduce the load, was great. In the compound engine, on the other hand, the gain rapidly decreases as the ratio of expansion at full load is made greater, while in the triple engine the gain by automatic expansion gear is inappreciable. In Mr. Willans' own words, "The question apparently turns on the question of the load at which the normal work is done." Thus, in an electric railway using compound engines, necessarily working under a fluctuating load, it is desirable to use an automatic expansion gear, not to take care of the light load as much as to momentarily give a much greater power than the normal at a slightly increased cost.

Now, in the central station lighting it will certainly be the one aim of the engineer, if he is at all capable, to so arrange his generating units that the engines may at all times work as far as possible at or near full load. Under these conditions, any slight gain when the power is reduced, due to automatic expansion, is not of any great importance, especially as the gain seems to almost disappear when high-pressure and triple-expansion engines can be used together.

One other experimental fact also came to light in these trials, and that was, that this law holds good at low as well as high speeds. The law limiting the number of expansions came into operation sooner at low than at high speeds.

I hope that I have not trespassed too much on your valuable space, but I feel that the matter is an extremely interesting one, and that Mr. Willans' experiments have done a great deal to elucidate it, and thus venture to draw both your attention and that of your many readers to the extremely valuable work of Mr. Willans, published in the "Proceedings of the Institute of Civil Engineers," Eng., Vol. CXIV.

W. E. BURGESS.

Development of Stationary Engines—Long vs. Short Connections to Indicator.

Editor American Machinist:

In Mr. Hemenway's interesting discourse on the "Development of the Stationary Engine," given in your issue of January 18th, I note a reference to the use of separate eccentrics for actuating the steam and exhaust valves in Corliss engines. It may be of interest to note in this connection that comparatively few English builders use the single eccentric gear so generally employed in the States. Effecting a compromise between the steam and exhaust valve movements appears to have proved a more difficult task to British constructors than to American, for the former used double eccentric Corliss gear more than a score of years ago. One of the pioneer users of the Corliss engine in England—the late William Inglis—adopted, I believe, some such arrangement as long ago as 1868, and the concern with which he was afterwards connected—Heck Hargreaves, of Bolton, England—used double wrist plate gear extensively. In the early 80s it had become common for high-class mill engines to be thus fitted, and although the wrist-plate has during the last few years almost wholly disappeared, independently operated steam and exhaust valves are now very generally adopted in England.

With regard to the large use made of the Willans engine for electric lighting in England, Mr. Hemenway is quite correctly informed. As instancing this, it may be said that in the total number of direct-driven central stations in Great Britain, outside London, over 80 per cent. of the power is furnished by these engines, to which must be added the power supplied by a very large proportion of the direct driven metropolitan stations. With regard to the interchangeable system of manufacture, the makers have recently stated that the engines made by them will be absolutely and at all times interchangeable with those by their American licensees, the M. C. Bullock Manufacturing Company, and also with those made by Messrs. Van den Kerchoul, of Ghent, their European licensees.

I notice that Mr. Crane states that long connections for indicators "have been defended for years both with theory and practice." I have only to say that I shall be very much obliged to your correspondent if he will refer me to any book or technical journal wherein I shall find enunciated the theory in defense of long pipes, to which he refers. Certainly, Mr. Crane doesn't appear to believe in the theory, or why did he—busy man that he is—attempt to remonstrate with those who requested him to use angle valves, pipes, and a three-way cock?

With regard to the movement of the steam in the indicator pipe, it does not require a very great intellectual effort to perceive that if condensation occurs, *some* steam flow must follow to compensate it. What I intended to convey—and what I think would be most generally understood from my remarks—was that it is not the friction of the steam in the pipe that produced the wiredrawn appearance often noticed in diagrams taken with long pipes, a feature especially prominent in the example I gave.

M. E.

Use of Slide Rule.

Editor American Machinist:

If, as described in my last on this subject in your issue of October 19th, the slide is taken out, turned over face for face and reinserted in the rule, so that the scale *T* shall be at the bottom of the slide next to scale *D* of the rule, with the right and left indices coinciding, we shall then have on scale *D* the tangents of all the angles given in degrees on scale *T*, beginning at the left with the angle 5° 42′ 38″, whose tangent is 0.1, and proceeding to the angle 45°, whose tangent is 1.0.

If it is required to find the tangent of an angle greater than 45°, bring the complement of the angle on the slide into coincidence with the left index of scale *D* of the rule, when under the right index of the slide will be found the tangent on scale *D*. Thus, what is the tangent of 56°?

T	Set 34°	Under 1	
D	To 1	Find 1.4825 = tan. 56°	

This method gives the tangents of angles up to 84° 17′ 22″, whose tangent is 10.0, which is ample for ordinary purposes of calculation.

Multiplication and division involving tangents are performed as follows:

1. Multiply 3 by tan. 20°, which is equivalent to divide 3 by cot. 20°.

T	Set 1	Under 20°	
D	To 3	Find 1.092	

2. Divide 218 by tan. 20°, which is also equivalent to multiply 218 by cot. 20.

T	Set 20°	Under 1	
D	To 218	Find 600	

3. Multiply 170 by tan. 75° 20′. This is equivalent to 170 ÷ tan. 14° 40′, so that we have in the preceding example:

T	Set 14° 40′	Under 1	
D	To 170	Find 650	

In a former number of your interesting paper (Query 338) I find this query: The height *A* and the angle *B* being given, how is the distance *C* found?

Let $B = 40°$ and $A = 5$ inches, then we have by trigonometry $C = A \div \text{tan. } B$, or $C = A \times \text{cot. } B$, which we solve exactly as our second example, thus:

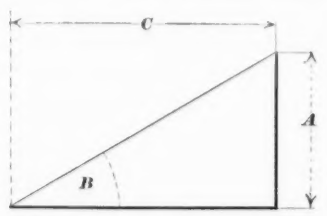
T	Set 40°	Under 1	
D	To 5	Find 5.95 inches	

Between the scale of sines and the scale of tangents on the slide there is a scale of 500 equal parts, numbered from 0 to 1,000, advancing by 2 units at a time, thus 0, 2, 4, 6, etc. These are the logarithms which correspond to the series of numbers on scale *D*. To find the logarithm of a number the slide is put in the rule in its ordinary position with scales *B* and *C* *uppermost*. The left index of scale *C* is then placed opposite the number on scale *D* whose log. is required; this latter is then found opposite an index in a small opening to the right of the *under* side of the rule. Thus, what is the log. of 2?

C	Set 1	Find on scale E. P.	.301
D	To 2	Against index on under side of rule	

This scale is very useful for finding high powers and roots, and solving such terms as $\sqrt{4^5}$, thus: By method stated above log. 4 is found = 0.602, and log. $\sqrt{4^5} = 0.602 \times \frac{5}{2} = 1.505$. We now bring .505 of the scale of equal parts to the index on the under side of the rule, and then find 32 on scale *D* under the left index of scale *C*. This is therefore the value of $\sqrt{4^5}$. The reason why we take .505 and not 1.505 will be evident to all those in the habit of using logarithms, seeing that 1 is the *characteristic* and 0.505 the *mantissa* which alone determines the corresponding number.

Before concluding I will give an easy solution of a practical problem which has



puzzled many, and which may be of interest to some of your readers, namely, to find the diameters of two wheels required to work at certain given velocities, the distance between the centers of the shafts being known. Example—The distance between two shafts is 60 inches. The driving shaft makes 40 revolutions and the driven shaft is required to make 50 revolutions. Find

the diameters of the necessary wheels. The rule is:

C	Set dist'ce between centers	Find diameter
D	To half sum of their revs.	Ab'e rev. of each

thus

C	Set 60	Find 53 3	Find 66 6
D	To 45 $\left(=\frac{40+50}{2}\right)$	Above 40	Above 50

The diameters of the wheels must therefore be 53.3 and 66.6 inches respectively. That this is correct is proved by $\frac{53\ 3+66\ 6}{2}$ = 60 = distance between shafts.

WM. COX.

Long Furnaces.

Editor American Machinist:

In your issue of January 11th, page 6, is given an illustration of a side center blast tuyere, by Thomas D. West. Permit me to ask Mr. West and others used to melting large amounts of pig-iron per day, why it is they continue to use large diameter furnaces instead of the long and narrow furnaces adopted by all the smelting works the last few years to obviate the "cold center"? I find in smelting that it is difficult to get the blast through a round furnace over 36" in diameter, and have adopted 33" as giving the best results, and by making the furnaces long get the area required. This should hold good in foundry practice as well as in smelters. P. C. FORRESTER.

Melrose, Cal.

The "Bramwell" Roller Square and Drawing Table.

With this we give illustrations of a roller square and a drawing table invented by Mr. Jos. W. Bramwell.

The square consists of a steel rod K, a carriage G, and the blade E. The rod K is supported by brackets secured to a table or portable frame F, as shown in Figs. 1 and 2. The carriage has four rollers turned to suit the bar; two of these rollers rotate upon pins fixed to the carriage, and the other two (next to the board) rotate upon pins fixed to spring boxes, as shown in section in Fig. 2. These spring boxes, in turn, slide upon horizontal pins held to carriage by set-screws. Each box is recessed for a spiral spring, one end of which pushes against the head of the pin, thereby pulling the fixed rollers against the bar. The pressure of the springs can be adjusted to suit tastes. With this arrangement the blade can be moved along the board with the greatest ease, and can also be completely swung off the board when desired.

The clutch swivel for the blade is clearly shown enlarged in Fig. 3. It is a disk accurately fitted into a split sleeve, the open ends of which are drawn together upon the disk by screw and thumb lever. The disk is bored to receive a vernier arm which moves with the blade.

In the ordinary protractor T-squares, the desired compactness limits the radius of the protractor, and consequently interferes to some extent with the accuracy of setting. In the Bramwell square the protractor, which reads to 3 minutes or less, consists of an arc of 30 degrees only, which permits the use of a comparatively long vernier arm without sacrificing compactness, and at the same time increasing the accuracy of setting the blade. It is obvious that with a vernier arm from four to twelve times as long as that in ordinary instruments the possible error will be reduced from $\frac{1}{4}$ to $\frac{1}{12}$., and with an arc of 30 degrees the space occupied by the protractor is one-sixth of that of an ordinary one designed for the same degree of accuracy. If a greater angle than 30 degrees is required, clutch the blade, move the vernier arm back, and proceed as before. Apart from this no other setting is required, and marring of the paper is avoided. When desirable the vernier arm can be readily removed. Civil engineers using oblique base lines will appreciate the advantages of this instrument. The Morse taper angles are also marked on the arc for the convenience of draftsmen who are frequently called upon to draw these tapers.

The most important features of this invention can be summed up as follows: (1) The square is self holding, and will leave the draftsman's hands free for other work; a slight pressure on the blade is sufficient to move it. (2) There is no varying edge controlling the position of square. (3) Total freedom from annoying variations due to shrinkage of board or paper. (4) A drawing of any length can be made on a small table by passing the paper from right to left over the edge of table or frame. (5) The board can be tilted to any desired angle. (6) The blade can be instantly converted into a straight-edge. (7) The blade rotates on the bar, leaving the board free for taking off or putting on paper, etc. (8) The blade can be rigidly held in any desired position. (9) The bar is adjustable vertically for any thickness of board from $\frac{1}{2}$ to $1\frac{1}{4}$ inches.

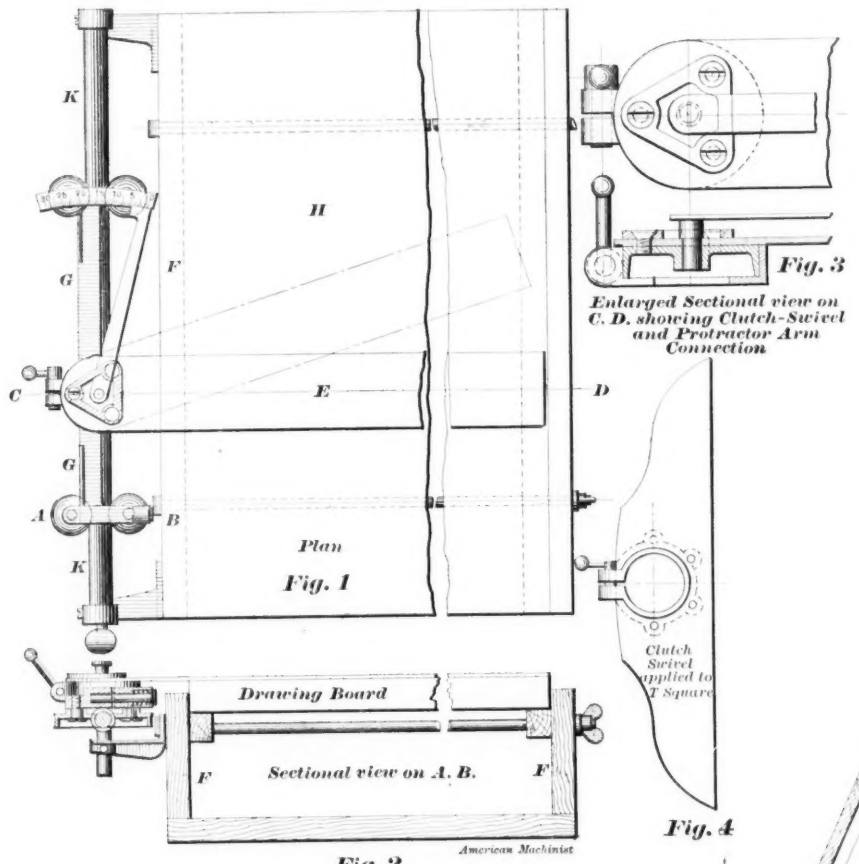


Fig. 1

Fig. 2

Fig. 4

Fig. 3

Enlarged Sectional view on C. D. showing Clutch-Swivel and Protractor Arm Connection

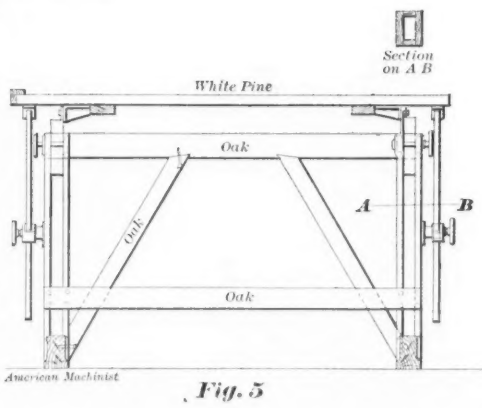


Fig. 5

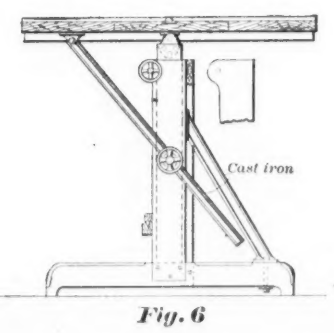


Fig. 6

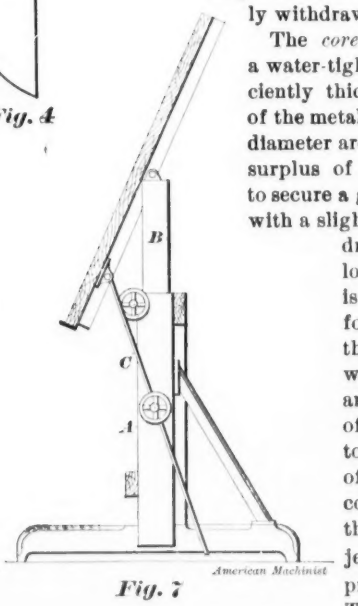


Fig. 7

Making Breech-loading Rifled Mortars.

The Builders Iron Foundry, of Providence, R. I., who for a few years past have been engaged in building breech-loading rifled mortars for coast defense, have recently published Part II. of "Our Share in Coast Defense," in which they illustrate and describe some of the processes of making these guns. As this is a matter of interest to mechanics and engineers, we, by permission, republish some of the illustrations and text accompanying them. In work of this kind done for the War or Navy Department, it is not the practice to simply specify that the job shall be "good and workmanlike," or "first-class." The specifications are much more definite and detailed. From the specifications we quote as follows:

FINISHING AND ASSEMBLING.

(*a*) *The bodies.*—The bore, cylindrical portion of chamber, and breech recess of the body must be smooth bored to 0 1 inch of finished dimensions, to admit of making accurate star-gauge measurements of these parts, to determine the compression due to the shrinkage of each row of hoops. The body is then to be centered by the bore, and the shrinkage surfaces for the hoops turned.

(*b*) *The hoops.*—The trunnion hoop must be completely finished before shrinkage. The cylindrical hoops must be finish-bored, rough-turned on the exterior to leave a surplus of from 0.125 to 0.1 inch over finished diameter, except such shoulder as may be desired for shrinkage operations, and be faced to length, except the two breech hoops which shall be left rough at the rear ends for finishing after shrinkage. In fine boring and facing the hoops for shrinkage, the allowed variation from prescribed diameters and for eccentricity and conicalness will be 0.003 of an inch. The allowed variation for length of hoops will be ± 0.01 of an inch, and for parallelism of ends 0 003 of an inch.

(*c*) *Assembling.*—The hoops of each row shall be applied under a definite shrinkage to be prescribed by the Ordnance Department. The allowed variation will be 0.003 of an inch.

For the operation of hooping the manufacturers must supply a suitable press to keep the joints between the hoops accurately closed while the applied hoop is cooling, and a circular sprinkling arrangement to cool the hoop uniformly by sections, beginning at the end first put on. The heating of the hoops for shrinkage must be conducted so as to insure a uniform temperature. The clearance on diameters for the assemblage may vary between 0.035 and 0.05 of an inch, not to exceed the latter, which corresponds to a maximum elevation of temperature of about 500° Fahr. above the temperature of the shops, except for the inner breech hoop, for which a maximum clearance of 0.04 of an inch over the shoulder will be allowed, which corresponds nearly to 625° Fahr. elevation of the temperature.

(*d*) *Finishing after assembling.*—After the hoops are assembled, the mortar shall be centered by the bore, and the exterior finish turned, before finish-boring and rifling. In finishing bore and chamber enough fine cuts must be taken to produce the best quality of finish. The shot chamber (conical) must be finished after rifling. After fine-boring and rifling, the bore and chamber shall be finished by lapping if required by the Ordnance Department.

The allowed variation in diameters of finished chambers and bore within lands, also diameters to bottom of grooves, will be + 0.003 of an inch, and — 0.000 inch. The allowed variation in width of lands or grooves will be ± 0.005 of an inch.

The thread shall next be cut in the breech and slotted; the breech end faced to length; the seat for the toothed arc and hinge plate in the inner breech hoop shall be cut, and the breech mechanism assembled. The vent bushing must be forced home by pressure to fill the undercut at bottom of seat.

MOLDING AND COOLING.

The *pattern* is usually constructed of wood made in as many sections and parts as may be necessary to admit of its being easily withdrawn from the mold.

The *core barrel* or *arbor* consists of a water-tight cast-iron tube, made sufficiently thick to withstand the pressure of the metal in the mold. Its length and diameter are such as to leave a sufficient surplus of metal in the bore of the gun to secure a good finish. It is constructed with a slight taper to facilitate its withdrawal after the casting. The lower end is tapered off and is fitted with several iron pins for securing the extremity of the rope, which is used as wrapping material in the preparation of the core; the exterior of the barrel is fluted from top to bottom to allow the escape of the gases generated by its combustion. Before being used the core barrel is always subjected to a powerful water pressure to test its soundness. To prepare the core for casting, journals are fitted at its extremities. It is then placed in a horizontal position upon an iron truck, supported by the journals resting in bearings, and turned by a crank attached to one of the journals. It is first wrapped with white hemp rope so as to cover all of the exterior surface in contact with the melted metal in the mold. Over this a coating of molding composition is applied quite wet, wrapped with twine or wire, to insure its adhering.

When the composition has partially dried another thin coating is applied and the surface rendered smooth and even by revolving the core in contact with a straight edge resting on the truck. The truck with the core is then rolled into the drying oven. When the composition is dried the core is removed from the oven and a coating of the same wash again applied. It is again replaced in the oven until thoroughly dry, when it is removed and the journals taken

(*Continued on page* 9.)

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J. G. A. MEYER, } Associates.
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High-grade Steam Engine Tests.

Steam engineering in this country is largely indebted to the technical schools for very important tests of steam engines that are from time to time made by the faculty and students of these schools, and published for the benefit of every one, such publication being made in the Transactions of the American Society of Mechanical Engineers, and otherwheres. These tests are not such as would be made by engineers in ordinary practice, because such engineers have very seldom the incentive to enter upon tests so complete in character; they can very seldom get paid sufficiently to warrant that completeness of detail necessary. Hence it is that the college tests, if they may be called such, have, or should have, a certain scientific value that does not attach to other tests, which are usually made for a specific purpose, and purely for commercial purposes.

There is every reason why these college tests—to continue the use of a term that may be considered objectionable—should possess scientific value. They are made with the assistance of a corps of students as observers, and with the instruction of these students—presumably—the main object in view. Inexactness is, or should be, inadmissible. When it comes to making a test of a steam plant that is to be published to the world, not only as something giving exact information on some point or points, but besides as an advertisement of the methods of an educational institution, we may expect exact methods to have been employed.

Any one who has given much attention to the testing of a steam plant has learned that one condition must not be offset against another that will presumably balance it. There must be no presuming. A result obtained by a general averaging up of things is useless for scientific purposes. No other example of this need be mentioned than the attempt to formulate the advantage of the steam jacket. This advantage has been shown to be all the way from a minus quantity up to 30 per cent. plus, and this may have—possibly—been true under a diversity of conditions. But the mere statement of its value in some particular case has led to the waste of a good deal of material and considerable steam, because the stated results would not obtain under different conditions. We may confidently take the tests made by a college faculty and students to give such precise information as to all existing conditions as to deter an outsider from making the costly mistake of thinking that he should use the steam jacket under all circumstances. And, finally, such tests should separate conditions, so that in the end every one will know under what conditions to use the steam jacket with the absolute certainty of improving economy. This is something very far from being the case now, but as well authenticated tests, under various conditions, are made matters of record, it is not too much to hope that it is an early possibility. Steam jacketing is only mentioned as convenient in the way of illustration, and because it has been such a conspicuous stumbling block.

In a general way, these fine tests of steam plants should be taken as the possibility and not the probability; that is, it should be understood that their value depends upon showing what might be and not what will be under ordinary operation. As an example, we remember at one time certifying to an 80,000,000 duty of a pumping plant. Some interest in the matter led to the determination of the fact that the regular every-day duty of this plant, under good ordinary management, was 60,000,000. This seemed to be too much difference, and, occasion soon offering, the expert duty of the steam plant of a mill was compared with the regular duty, the difference being almost identical in the two instances. We do not believe there would always be so great a difference found, but, on the other hand, we believe that in some instances it would be even greater than this.

The purely practical man is generally a little inclined to set at naught expert tests of steam plants, in which he is partly right, but mostly wrong. What a man who pays the cost and the current expenses of a steam plant wants to know is, how much it will cost him to operate it day by day with such help as he can and will naturally obtain. This is a matter of every-day test by his engineer. This test will not stand the figures of the critic, neither is it necessary that it shall; it shows the *facts* of ordinary operation, and the possibility under such operation of varying conditions at command

It might, then, be inferred that the constructor and the purchaser of steam engines were alone interested in the results of scientific tests. This would be far from the truth. No one is more interested than the operating engineer. Understanding, as he does, that he can never reach the high mark of the expert test, he has a lively interest in knowing what the possibilities are, and is always interested and instructed in his efforts to approach it.

By all means let us have more and more exact tests of steam plants—they are sure to be instrumental for good. Their records, properly condensed, framed and hung up in engine rooms, would have an educational effect.

George W. Childs.

The universal sorrow manifested on account of the death of George W. Childs, of Philadelphia, shows how much hold a man may acquire upon the hearts of his countrymen by simply living the life of an unselfish, honest and simple citizen.

Without remarkable talents, without official position or influence, Mr. Childs yet wielded a tremendous influence for good, simply because he combined good business ability with an uncommon love for and devotion to his fellow man, and his death has called forth a tribute which the most powerful ruler may envy.

His character was well illustrated by the relation he sustained to his employes. In 1876 the Typographical Union reduced the rates of composition from forty-five to forty cents. A committee waited upon him, informing him of this fact. His reply was to the effect that he sold his paper at the same price and received the same price for adver tisements, and did not see why the price of composition should not remain the same, all profiting by the general prosperity. And so it went to the end, he paying in the way of wages ten thousand dollars a year more than strict Union rates, all the while paying wages to those who had become incapacitated—by years or otherwise—in his service. During his lifetime he gave away many thousands of dollars, and always with such good judgment as to invariably accomplish the good he intended. He never pretended to be else than a man and a good citizen, and he was these in the fullest sense.

Percentage, though one of the simplest things in the world, will always remain a profound mystery to many mechanics, mainly because they lack the inclination to sit down some evening for an hour or so and master it. A manufacturer of a safety device for emery wheels was not long ago very forcibly reminded of the existence of this bugbear. He put his wheels and safety device into a shop, giving them permission to run 10 per cent. faster than they had been running with the old wheels and collars. This was interpreted to mean that 10 inches could be added to the diameter of the pulley on the line shaft, which happened to be 18 inches diameter, which, increased to 28 inches (their idea of an increase of 10 per cent) gave an increase of over 55 per cent. in the speed. The wheel burst at this speed, as, of course, it should have done, though, fortunately, the safety device retained its fragments and prevented a fatality.

The simple fact that per cent. means per hundred, and that 10 per cent. added to a number means 10 added for every hundred, or $\frac{1}{10}$ for every unit. and that therefore an 18-inch pulley increased 10 per cent. would be increased $\frac{1}{10}$ inch for every inch of its original diameter, making it $19\frac{8}{10}$ inches diameter would seem easy to be understood, but here was a man having charge of machinery, where a misapprehension of it was liable to result in a fatal accident, and who had yet evidently never taken the least pains to inform himself upon so important a matter.

A manufacturer of machinery, in conversation the other day, took an optimistic view of our present business depression, expressing his belief that as we had passed through and recovered from commercial and industrial depressions before, so we would again. He thought there were some generally overlooked causes that had been working toward the present condition of affairs, and prominent among them had been depression of foreign business, one result of this being that for the past two years, and until very recently, his establishment had shipped absolutely no machinery to Australia, whereas for some years previous to that time they had made a monthly shipment of machinery to that country upon a standing order.

Another cause had been the World's Fair. About $35,000,000 worth of American manufactured goods had been made for exhibition there. These goods had been made during 1892, when regular business was unusually good, and had been just that much made in excess of regular demand—by pushing things, and by working nights in many instances. At the close of the Fair these goods were available for filling orders, and current production must, therefore, necessarily be correspondingly below the demand, the net effect being, therefore, to unduly stimulate an already rushing manufacturing business during 1892, and correspondingly depress a very dull business at present.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(73) C. C. M., Joplin, Mo., writes: Please inform me in which numbers of the AMERICAN MACHINIST I can find instructions for making blue prints. *A.*—See answer to Question 375 in our issue of July 27, 1893.

(74) R. J., Altoona, Pa., writes: The diameters of the steps of a cone pulley are $1\frac{1}{8}$, $2\frac{5}{16}$, 3 and $3\frac{3}{4}$ inches; the diameter of the largest step on the other cone pulley is 30 inches, what should be the diameters of the other steps? Please give rule for finding these diameters. *A.*—We cannot give you the diameters of the required steps, because you have not given the distance between the centers of the cones. You will find a graphical method for finding these diameters in our issue of December 1, 1888. It takes up too much space to repeat it in these columns.

(75) D. P., Montreal, Canada, asks: Can aluminum metal be used with less cost than iron in the manufacture of counter scales? *A.*—Aluminum, particularly when alloyed with some other metal, can be advantageously used for the purpose named, but we have not had sufficient experience in the manufacture of scales to give relative costs. 2. What would be the cost per ton in pig, and where can it be obtained? *A.*—The Pittsburgh Reduction Company, and the Cowles Electric Smelting and Aluminum Company are the only concerns, as far as we know, manufacturing commercially and furnishing the American market with aluminum. Write to these companies for price.

(76) Reader, Peekskill, N. Y., writes: I have some chilled car wheels that are worn flat in places, and a customer wishes me to turn them true. I have tried Mushet's steel, but it has not the desired effect on the wheels. Kindly advise me if they could be annealed so that I could turn them easily. Which would be the cheapest way of annealing them? Or, is there any other way of doing this kind of work that could be suggested? How would grinding work? *A.*—Annealing the wheels is not practical.

Probably the best method is to grind them. Or, if you write to some steel manufacturer and state the kind of work you wish to do, he may take pride in sending a quality of steel that will answer the purpose.

(77) I. B., Taunton, Mass., writes: Please inform me if there are in this State or the New England States any manufacturers of aluminum? *A.*—There are none in the New England States. As far as we know, there are two concerns only in the United States which manufacture commercially and furnish the American market with aluminum, the Pittsburgh Reduction Company and the Cowles Electric Smelting and Aluminum Company. 2. Are there any books or articles treating on the process of manufacturing aluminum? *A.*—"Aluminum and its Alloys," by Richards, treats to some extent on its manufacture, properties, etc. The process of manufacturing is patented and can be used by those only who have a right to use it.

(78) A. W. M., Boston, Mass., writes: Kindly give me a rule by which I can determine the distance the tail center must be set over to turn any given taper. *A.*—Multiply one half the taper per inch by the length of the work in inches. The result will be the distance to set the tail center over, or, rather, it would be if it were not for the fact that the center enters the work an indeterminate distance, which fact complicates the matter somewhat, and makes the rule approximate only. It will be noticed that this differs somewhat from the rule given in answer to Question 19, issue of January 11th, where we inadvertently stated that half the difference in diameter between the two ends of the tapered portion should be taken, instead of half the difference in diameter *per inch*.

(79) L P., Potsdam, N. Y., writes: Please give me the simplest rule for computing the gears required for cutting threads in a lathe, and state whether the rule will apply to any lathe. Can you recommend a book that treats on this subject; if so, where can I obtain one? I notice that in some of your answers you refer the reader to back numbers; if you answer my question in this way, kindly state if I can obtain the number to which you refer. *A.*—For computing the size of gears, see answer to Question 85. A short chapter is devoted to this subject in "Formulas in Gearing," published by Brown & Sharpe Manufacturing Company, Providence, R. I. We can always furnish any issue of the AMERICAN MACHINIST to which we may refer in the Question and Answer columns.

(80) W. J. G., Drifton, Pa., writes: Please advise me as to the name and publisher of a first-class book on high speed automatic steam engine design. *A.*—It is a difficult matter to select suitable books on any subject for our different classes of readers. There are many books published treating on different classes of engines and from different standpoints, and it may be that you will need more than one book before you can obtain a thorough knowledge of steam engine design, and even with the knowledge gained in this way, however valuable and indispensable it will be, it is doubtful if you will become a proficient designer without having considerable practical experience. In fact, the endeavor to gain practical experience frequently points out the books that are needed in pursuing the profession, and is probably the best guide for the selection of books. However, D. K. Clark's "Steam Engine," a treatise on steam engines and boilers, we believe to be a good work and may suit your purpose. We should advise you to examine it before buying. You can obtain this work from any dealer in scientific works.

(81) N. L., Richmond, Va., writes: Please answer the following questions: What grade of wheel is best suited to sharpen horse clippers, and what should be the speed of the wheel for work of this kind? *A.*—The best course for you to pursue will be to state, in ordering the wheel, what kind of work the wheel is to be used for, by so doing you will have more satisfactory results than by attempting yourself to specify the kind of wheel you need; in fact, manufacturers generally ask for this information so as to enable them to fill the order satisfactorily to all concerned. The speed depends much on the grade and make of wheel; it is, therefore, impossible to give a rule that will determine the safe speed of all wheels. It may, however, be said that a surface speed of a mile a minute is generally safe for all kinds, and for some wheels this speed may be much increased. 2. Which will be the best, a wet or dry wheel? *A.*—The wet wheel will probably be best suited for your work. It should be stated that the wheels should be run in a machine adapted to the work, otherwise very unsatisfactory results may follow. Without a suitable machine, the clippers had better be sharpened by lapping with cast iron plate.

(82) P. H. R., West Pittston, Pa., writes: I would like to have you give me a rule for computing the length of a safety valve lever when the weight, steam pressure, size of valve and the distance from the fulcrum to the valve are given. *A.*—Multiply the steam pressure per square inch by the area of the valve in square inches and by the distance in inches from the center of valve to the fulcrum; call this product 1. Multiply the weight of the valve and spindle by the distance from the center of valve to the fulcrum; call this product 2. Multiply the weight of the lever by the distance in inches from the center of gravity of the lever to the fulcrum; call this product 3. If the lever has the same depth and thickness throughout its length, the center of gravity will be in the center of the lever; if the depth or thickness decreases towards the end, find the center of gravity by balancing the lever on a knife's edge. From product 1 subtract products 2 and 3, and divide the remainder by the weight to be placed on the end of the lever, the result will be distance in inches from the center of weight to the fulcrum. A formula has been given in answer to Question 600 in our issue of December 7, 1893, from which all the rules for the solution of safety valve lever problems, under various conditions, can be obtained.

(83) M. L., Italy, writes: Kindly answer the following: 1. How is the surface of a frustum of a cone developed? *A.*—The development of conical surfaces is thoroughly explained in our issue of December 19, 1889. 2. What is the composition of aluminum, and what is its price? *A.*—Aluminum is not a composition; it is a light, bluish-white, malleable and ductile metallic element. The price is 70 cents to 75 cents per pound, according to quality; for lots less than 1 ton, 10 cents per pound additional. 3. When and where was the steamship "Great Eastern" built? And for which company was she built? *A.*—The "Great Eastern" was built for the Eastern Steam Navigation Company. The hull and paddle engines were built by Messrs. Scott, Russell & Co., of London (England); the screw engines were built by Messrs. James Watt & Co., Soho Works, near Birmingham. The original conception of building so large a steamship was due to Mr. I. K. Brunel, the steamship company's engineer. The first plates of the flat portion of the bottom of the vessel were laid on May 1, 1854, but it was not till November 3, 1857 that she was ready for launching, and the vessel was got into the water January 31, 1858. The company's funds becoming exhausted, the vessel lay in the Thames for more than a year, with all work stopped upon her, when she passed into the hands of a new company called the "Great Ship Company." She made her steam trial in September, 1859. She was finally put into the Atlantic trade, and made nine transatlantic voyages between 1860 and 1863. Owing to the impossibility of working upon the Atlantic at a profit, the ship passed into other hands, and was afterwards occupied chiefly in cable laying. After the demand for her employment in this work fell off, she lay many years, uncared for, in Milford Haven, and was at last sold and broken up. 4. Is it true that the Krupp's Works is the greatest in the world? *A.*—We believe it is. 5. On what date was the Brooklyn Bridge opened for traffic? *A.*—May 24, 1883.

(84) G. M., Baltimore, Md., writes: I want to build a ½ horse power oscillating engine; the steam ports are to be in a casting which is screwed to one end of the cylinder. The engine is to run at a rate of 200 revolutions per minute; boiler pressure 100 pounds. What should be the size of the cylinder, steam and exhaust port? *A.*—Diameter of cylinder 2½ inches, stroke 3 inches. The area of each steam port, also the area of the exhaust port, should be ⅛ square inch. 2. How do you compute these dimensions; please give the simplest way? *A.*—The simplest way of computing the size of cylinder is to assume the diameter or the stroke. If, for instance, we assume a stroke of 3 inches, we can find the diameter as follows: Multiply the given horsepower by 33,000 and divide this product by the mean effective steam pressure per square inch, and by the piston speed in feet per minute, the result will be the area in square inches of the cylinder. For the mean effective pressure in preliminary computations of this kind we take one half of the boiler pressure. If H = the required horse power, P = mean effective steam pressure, S = piston speed in feet per minute, and A = area in square inches of the cylinder, we have

$$\frac{H \times 33\,000}{P \times S} = A.$$

Substituting for the symbols their values as given by you, we have:

$$\frac{\frac{1}{2} \times 33,000}{50 \times 100} = A = 3.3 \text{ square inches};$$

the corresponding diameter is 2¼ inches very nearly. There is hardly any necessity of computing the area of the steam ports for engines as small as this one, as the size obtained by computation will be smaller than is practical to cast them. The area of ports as given by us is plenty large enough, and yet none too large for obtaining a good casting without incurring an undesirable expense in making it. 3. I also want to make a boiler of porcupine type out of common steam pipe for supplying steam to this engine. The center pipe is to be 3 inches in diameter and 20 inches long. Now, I would like to know what size and how many pieces of pipe I will need to screw into the center pipe, allowing about 5 inches of the top end of the pipe for a steam drum. The whole is to go into a shell 11½ inches inside diameter? *A.*—In our opinion the center pipe is not large enough in diameter nor long enough, and the inside diameter of shell is too small to accommodate a sufficient number of pipes for the work the boiler has to do. If, however, you insist on retaining these dimensions, put in as many pieces of ¾ inch pipe as you can crowd around the 3-inch pipe.

(85) L. E. A., Plymouth, Mass., writes: Please inform me the quickest way to calculate both simple and compound gearing for thread-cutting where there is no index? *A.*—If the lathe is simple-geared, and the stud runs at the same speed as the spindle, then select some gear for the screw, and multiply its number of teeth by the number of threads per inch in the lead screw, and divide this result by the number of threads per inch which you wish to cut. This will give you the number of teeth in the gear for the stud. If this result is a fractional number, or a number which is not among the gears which you possess, then try some other gear for the screw. But if you prefer to select the gear for the stud first, then multiply its number of teeth by the number of threads per inch which you wish to cut and divide by the number of threads per inch on the lead screw. This will give you the number of teeth for the gear on the screw. If the lathe is compound select at random all the driving gears, multiply the numbers of their teeth together, and this product by the number of threads you wish to cut. Then select at random all the driven gears except one; multiply the numbers of their teeth together, and this product by the number of threads per inch in the lead screw. Now divide the first result by the second, and you will have the number of teeth in the remaining driven gear. But if you prefer, you can select at random all the driven gears. Multiply the numbers of their teeth together, and this product by the number of threads per inch in the lead screw. Then select at random all the driving gears except one. Multiply the numbers of their teeth together, and this result by the number of threads per inch of the screw you wish to cut. Divide the first result by the last, and you will have the number of teeth in the remaining driver. When the gears on the compounding stud are fast together, and cannot be changed, then the driven one has usually twice as many teeth as the other or driver, in which case you can, in the calculations, consider the lead screw to have twice as many threads per inch as it actually has, and then ignore the compounding entirely. Some lathes are so constructed that the stud on which the first driver is placed revolves only half as fast as the spindle. You can ignore this in the calculations by doubling the number of threads of the lead screw. If both the last conditions are present you can ignore them in the calculations by multiplying the number of threads per inch in the lead screw by four. If the thread to be cut is a fractional one, or if the pitch of the lead screw is fractional, or if both are fractional, then reduce the fractions to a common denominator, and use the numerators of these fractions as if they equaled the pitch of the screw to be cut, and of the lead screw respectively. Then use that part of the rule given above which applies to the lathe in question. For instance, suppose it is desired to cut a thread of $\frac{25}{8}$ inch pitch, and the lead screw has 4 threads per inch. Then the pitch of the lead screw will be ¼ inch, which is equal to $\frac{8}{25}$ inch. We now have two fractions, $\frac{25}{8}$ and $\frac{8}{25}$, and the two screws will be in the proportion of 25 to 8, and the gears can be figured by the above rule, assuming the number of threads to be cut to be 8 per inch, and those on the lead screw to be 25 per inch. But this latter number may be further modified by conditions named above, such as a reduced speed of the stud, or fixed compound gears. In the instance given, if the lead screw had been 2½ threads per inch, then its pitch being $\frac{4}{10}$ inch, we have the fractions $\frac{4}{10}$ and $\frac{25}{8}$, which, reduced to a common denominator, are $\frac{64}{160}$ and $\frac{125}{160}$, and the gears will be the same as if the lead screw had 125 threads per inch, and the screw to be cut 64 threads per inch. 2. Please also give me the rule for setting for taper in the lathe such as for connecting rods. *A.*—No rule can be given for this which will produce exact results, owing to the fact that the centers enter the work an indefinite distance. If it were not for this circumstance the following would be an exact rule, and it is an approximation as it is. To find the distance to set the center over: Divide the difference in the diameters of the large and small end of the taper by 2 and multiply this quotient by the ratio which the total length of the shaft bears to the length of the tapered portion. For example, suppose a shaft three feet long is to have a taper turned on the end one foot long, the large end of the taper being two inches and the small end one inch diameter. The difference between the diameters of the large and small ends is one inch, which, divided by two, gives one half inch. The whole length of the shaft being three feet, and the tapered portion one foot, the ratio between their lengths is three, and one half inch multiplied by three gives one and a half inches, the amount to set the center over. This, as said above, however, will be modified to some extent by the fact that the centers enter the work an indefinite distance. An article giving a method of computing the gears for the nearest possible approximation to a given fractional thread with any given set of change gears, by George B. Grant, will be found in our issue of April 2, 1891, and in issue of November 9, 1893, is given a graphical method by W. H. Croker.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 12.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Turret Drills, 6 spind es. A. D. Quint Hartford, Ct.

Chucks, the Nat'l, est'd 1882 39 Cortlandt St., N. Y.

Speed Gage McLauthlin & Co., Fulton St., Boston.

Pattern and Brand Letters A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Seiden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for exp'l purposes, 300 lbs., $50. Clayton Air Compressor Works, 45 Dey st., N. Y.

Steam Pressure Regulators, Reducing Valves, Safety Checks. Foster Engineer'g Co., Newark, N. J.

Upright Drills, stationary head, W. & L. with or without B. G. J. E. Snyder, Worcester, Mass.

M. E. Howard, Indianapolis, Ind. Specialty, 4 and 8 H. P. engines in stock, write for price.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Vocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

Most sensitive and durable Damper Regulator made; works within one pound. Send for circular. T. Kieley, 11 W. Thirteenth Street, New York.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery" New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

American Packing Rings make pistons steam tight. Are simple, durable and inexpensive; write for circular. J. H. Dunbar, Youngstown, O.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Making Breech-loading Rifled Mortars.

(*Continued from page* 7.)

out. The top is fitted with a water-tight cap so constructed as to receive the conducting pipes for the water, and is ready for use.

The *pit*, as usually constructed for the casting of guns on the Rodman plan, is cylindrical in form and is surrounded with a brick wall, built in offsets, affording supports for braces to steady the mold in position; grates are arranged around the circumference of the bottom for fires lighted immediately after the casting to retard the radiation of heat from the exterior of the mold. To retain the heat of the fires in the grates the mouth of the pit is covered with a close fitting cover of boiler iron.

Casting.—The iron for the gun is melted in reverberatory air furnaces, two or three

being sometimes required for casting the heavier guns. In these furnaces the draught is produced by high chimneys instead of a blast, which is used in the cupola furnace. The metal for what is termed a "heat" is all placed in the metal chamber before the fire is lighted. The fuel, bituminous coal, is placed on grate bars in the fuel chamber, and, when ignited, the flame passes through the metal chamber on its way to the chimney. The iron is melted by this flame without coming in contact with solid carbon at all, unlike the cupola furnace, where the fuel and iron are mixed together.

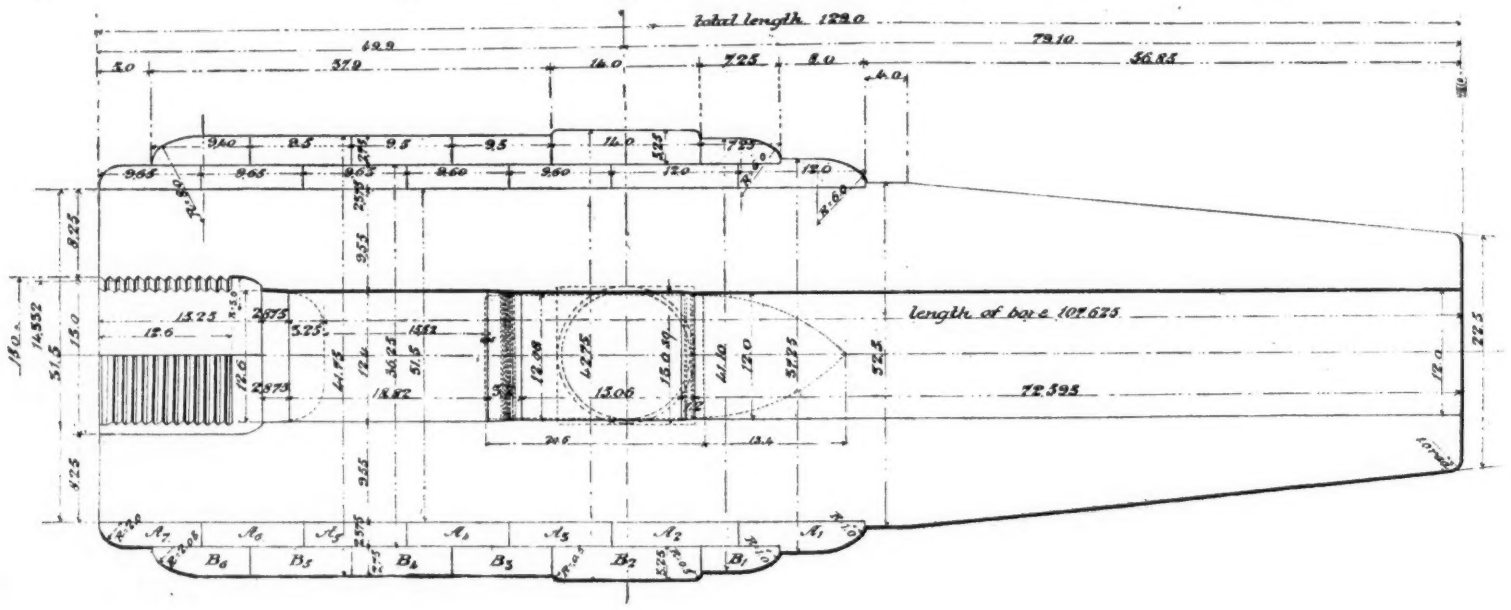
The different grades of iron to be used for the heat are weighed and piled in proper proportions in the metal chamber. Care should be taken to have the furnace perfectly dry throughout. When it has been out of use long enough to become damp, it should be dried by a fire in the fire-chamber before being charged.

tained to be fairly down, specimens are taken out to determine whether the iron is sufficiently decarbonized or "high" to be in a proper condition for casting. These specimens are cast in green-sand molds and broken as soon as they become cold. The condition of the iron is indicated by the appearance of the fracture, and varies so much with different brands used that its determination is largely a matter of experience.

If the first specimens show insufficient decarbonization, the iron is kept in fusion still longer and the puddling process is continued.

As the density and tensile strength of the iron depend in a great measure upon the highness to which it is brought, a correct decision is very important.

As soon as the melted metal in all the furnaces is found to be in proper condition for casting, the furnaces are tapped simultaneously and the metal conducted by troughs to the mixing basin, where the several charges are thoroughly mixed. It then flows on through other troughs connecting with the side gates of the mold, and, passing down, enters the mold cavity by the branches. These branches connect with the side gates at regular intervals, and are so constructed that the metal enters in a horizontal direction toward the axis of the mold cavity. The surface of the metal, as it enters, is stirred to prevent the scoria from lodging; care should be taken not to give it a "swirl," which throws the lightest metal in around the core, where the heaviest and best should be. When the mold is filled, the tap holes of the furnaces are closed, and the surface of the metal in the sinking head is covered with a layer of charcoal to prevent its chilling. For two or three hours after the casting more metal is added at short intervals of time to feed the shrinkage, by pouring from a ladle at the top of the mold as the surface sinks.



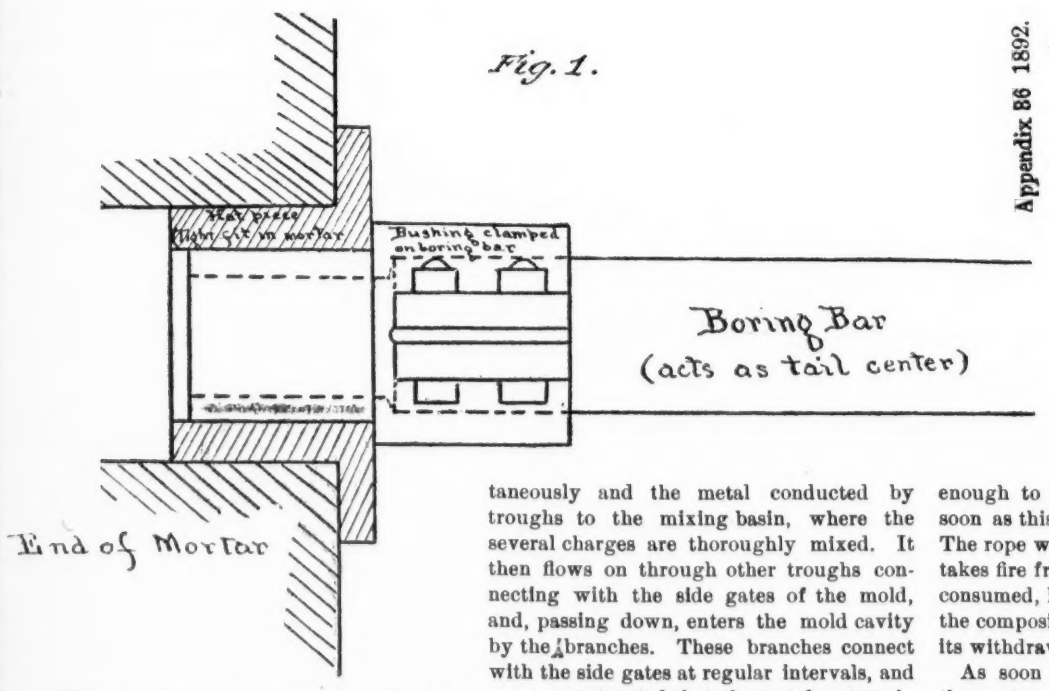


Fig. 1.

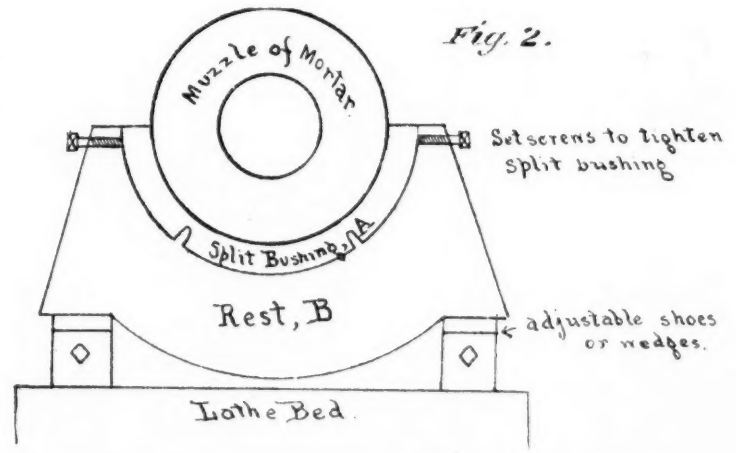


Fig. 2.

Method of Holding Muzzle of Mortar while boring.

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When two or more furnaces are used in casting a gun, the tap-holes are connected by troughs with a reservoir called a mixing basin, in which the different charges are thoroughly mixed before entering the mold.

The furnaces being charged and everything in readiness, the fires are started and regulated so that the iron in all will be melted or "down," as near as practicable, at the same time. The length of time required to obtain complete fusion depends in great measure upon the state of the atmosphere and quantity of metal in the charge; it may vary from five to twelve hours.

When the charge is nearly down, wooden poles or iron rods are inserted in holes provided for that purpose in the walls of the furnaces, and the melted metal frequently stirred or puddled to bring the unmelted lumps in contact with the flame. As soon as the charge of a furnace is ascer-

Cooling.—The water for cooling the gun is taken from a hydrant where the supply is constant and uniform. It is conducted into the core by means of a metallic tube which passes through a water-tight joint in the center of the cap and extends to within a few inches of the bottom of the barrel. The water consequently passes into the core at the bottom and ascends until it reaches the escape pipe and is discharged.

The flow of the water commences as soon as the furnaces are tapped, and is regulated to produce, half an hour after the casting, a certain change of temperature, about 25°, between entering and leaving the core. When this is effected the rate of flow remains constant until the core is removed.

As soon as possible after the casting the fire in the pit is kindled, and kept up until the withdrawal of the core barrel; it is allowed to die out gradually. Meanwhile the mouth of the pit is kept closely covered.

When the change of temperature of the outflowing water has become constant or nearly so, the core barrel is withdrawn. To effect this, it is sometimes necessary to largely increase the flow of water for a short time, in order to contract the barrel enough to loosen it from the casting. As soon as this is effected the flow is stopped. The rope with which the barrel is wrapped takes fire from the heat of the casting and is consumed, leaving the barrel detached from the composition surrounding, and allowing its withdrawal without difficulty.

As soon as the core barrel is withdrawn the water is turned into the bore, being conveyed by the conducting pipe to the bottom, and escaping by means of a tube cast into the gun head, entering the bore a few inches from the upper end of the casting. The rate of flow of the water through the bore is so regulated as to produce a change of about 100° between entering and leaving at half an hour after the removal of the barrel. It is then allowed to remain constant until the gun becomes cool. The time occupied in cooling by this process varies from four to six days, according to the size of the gun.

MACHINING.

Turning body for A hoops and rough-boring of mortar.—The first operation consists in cutting a notch near the outer edge of face of breech for the reception of a hook secured to the head-stock face-plate, by which the mortar body is rotated. A "hat piece," having a very slight taper, about 0.02 in a length of four inches, is next driven firmly into the muzzle end of the bore. A similar "hat piece" is bolted to the head-stock face-plate. The body is then placed in the lathe. A center piece or bushing on the front end of the boring bar enters the muzzle hat piece. The latter turns about the former when the mortar revolves. The boring bar abuts against a shoulder on the outer end of the center piece, and thus (Fig. 1) keeps the mortar bearing against the lathe face plate.

The second operation consists in turning down the breech end to the finished size for about 15 inches for the reception of a clamp ring (two halves), which are then secured to the face-plate by bolts to keep the mortar from sliding to the front during the boring. About 6 inches of the muzzle end are then turned down cylindrically to a diameter of 24 inches, in order that it may fit in a rest, *A*, Fig. 2. This rest fits in another rest, *B*, which stands on the ways of the lathe and is made adjustable by wedges *C* between it and the ways. The muzzle hat piece and center piece are now removed. The hat piece bolted to the face-plate has a taper hole at its center for the reception of the tapered front end of the boring bar. The rear end of the boring bar is secured to a steady journal that is firmly clamped to the tail-stock. The boring bar thus stands fast during the operation of boring. A washer between its front and the face plate hat piece diminishes friction between these two surfaces when the latter revolves. A feather key runs the entire length of the bar. The cat-head, or head carrying the boring tool, Fig. 3, has a groove on its inner surface for the reception of the feather on the bar. This enables the head to slide along the bar, but not to rotate. Two rods of somewhat greater length than the bore are screwed into the rear of the cat-head. The rear ends of these same rods are screwed into a crosshead, to which a nut on the feed screw in the tail-stock is bolted. As the nut is fed forward or backward it carries the crosshead with it, and this in turn operates the cathead, through the medium of the two long bars. The boring is done by the withdrawal of the head rather than by a forward push. Dur-

ing the turning down of the exterior three chips are taken with the boring tool, and finally the bore is reamed once. The reamer has several cutting edges let in a cylindrical head. The gun is next turned end for end in the lathe, in order to bore the powder chamber. In this operation, the interior rest *A*, at the muzzle end, is removed and the clamp (ring) on the breech end fits in the exterior rest *B*, Fig. 1. After the body is turned on the exterior to the required dimensions, which are determined as shown below from the interior diameters of the *A* hoops, these having been measured at every inch in the length of the hoops and in two directions at right angles to each other, it is calipered by the inspector at every inch of its turned length on two diameters, also at right angles to each other, to verify the accuracy of the work.

A table similar to the following, except that the actual interior diameters of *A* hoops are entered instead of the standard, is furnished the company by the inspector, a duplicate copy being retained by him:

1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

The *A* hoops having been shrunk on, as will be explained later, the bore is star-gauged to ascertain the compression due to the hoops, and the exterior diameters of the hoops are measured to find the increase due to their expansion over the body. The mortar is then returned to the lathe.

Turning down exterior of A hoops.—For turning down the exterior of *A* hoops, the arrangement is the same as that for turning down the rear portion of the cast-iron body, the same lathe being used. A table for the required dimensions from the interior diameters of the *B* hoops, similar to the following, governs the workman as in the turning of the mortar body. When finished, the exterior is calipered by the inspector as before. The mortar is then transferred to the hooping room and the *B* hoops are shrunk on. The bore is again star-gauged and the exterior diameters of the *B* hoops measured to determine their increase in length.

1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

Turning down exterior of mortar (*B hoops and chase*).—For turning down the exterior of the mortar another lathe is employed. A bushing, Fig. 4, sufficiently long to reach the front end of the powder chamber, and to project about 18 inches to the rear of the mortar, and of an exterior diameter nearly equal to the bore of the chamber, is inserted from the rear. The front end of the bore of the bushing is a conical frustum with its larger base to the rear. Three slots are cut entirely through the conical end of the bushing to admit of its expansion in the bore. A long rod, with a corresponding frustum on its rear end, extends from the bushing clear through the bore of the mortar, the lathe spindle in its muzzle, and through the head-stock of the lathe. The outer end of the rod is threaded for a nut, which bears against the head stock and by means of which the mortar is drawn firmly to its place. At the same time the frustum on its rear end expands the front of the bushing tightly in contact with the bore of the mortar. An arbor or tail center inserted in the rear end of the bushing, in which it closely fits, rests on a support on the ways of the lathe and sustains the rear of the mortar. The muzzle end of the mortar is sustained by the lathe spindle, which in turn rests on another support on the lathe ways.

Two tool carriages are employed, one for the *B* hoops and one for the cast-iron chase, the latter being inclined to the axis of the bore to give the necessary taper to the chase.

Boring of the hoops.—The hoops are bored and faced in the boring-mills, whose tables, to which the hoops are firmly secured, revolve in a horizontal plane. The tool carriage is above the level of the table. A portion of the *A* hoops were bored on a lathe, but the work was unsatisfactory, the turned surface being rough and the bore often eccentric, the latter due, it is thought, to the weight of the hoops, causing them to elongate when the hoops stood on their sides. The hoops are first faced on one end. They are then turned over so as to rest on the squared surface when they are bored, and the other end faced off, bringing them to the prescribed length. When taken from the mill they are laid flat on the floor and the mean interior diameters determined by measuring on two diameters at right angles to each other at every inch of the length of the hoop. The trunnions of the trunnion hoop are turned in a lathe before the hoop is bored. Its exterior is afterwards finished in a slotter.

Hooping of the mortars.—The mortar is placed on a truck running on a railway track leading from the lathe to the heating pit. It rests on a single support on the truck, somewhat in advance of the position that the hoops will occupy. A strap over the muzzle and secured to the truck prevents the breech from coming in contact with the truck, thus leaving the rear end free to receive the heated hoops. A trolley rail runs immediately over the axis of the truck, on which five trolleys are placed. To each of these a Yale triplex pulley hoist is connected. The first supports the side screws of the press for drawing the hoops into their proper positions and holding them there while cooling. The second supports a water ring, pierced with small holes, by which the hoops are cooled. The third sustains the hoop while being slipped on the mortar, and the fourth the collar which bears against the hoop to force it to its position. The fifth is used to lower the hoop into the heating pit and to transfer it from the pit to the floor immediately in the rear of the mortar. The press consists essentially of a crosshead or equalizing bar at the muzzle of the mortar, two heavy side bars, somewhat longer than the mortar, and the collar. The ends of the crosshead are bored to admit the side bars. The front ends of the bars are threaded for nuts, which, through the intervention of ball-bearings, abut against the crosshead. The rear ends of the bars are T-shaped to lock into recesses cut in the sides of the collar.

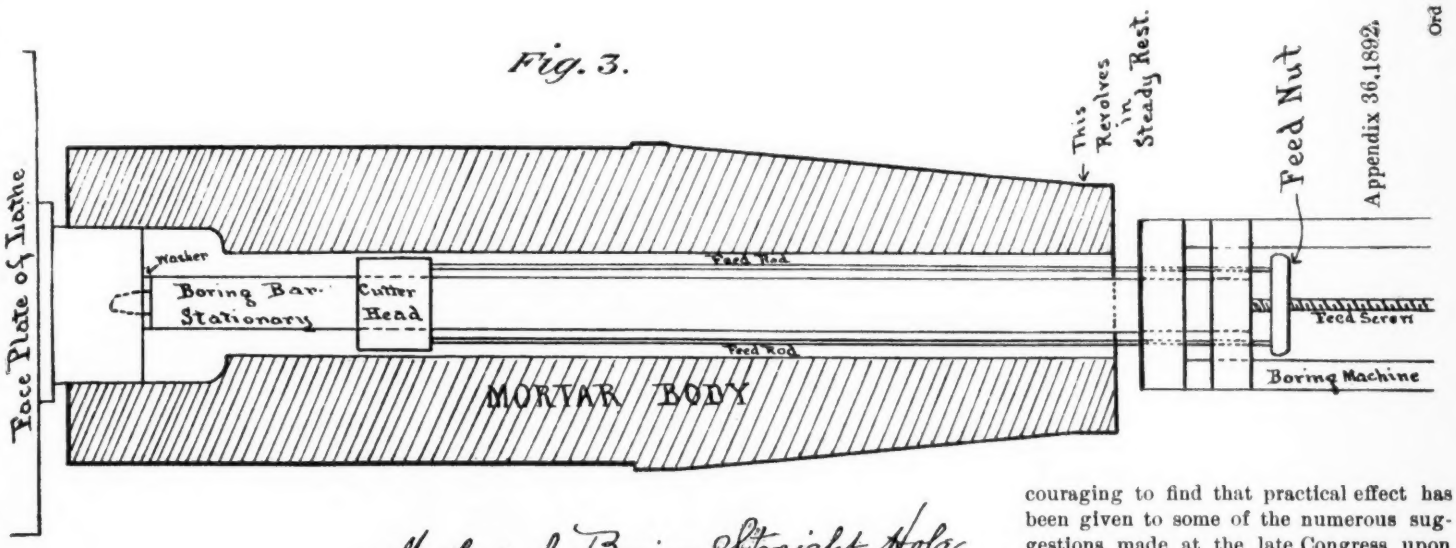
The heating pit.—The pit is about 2 feet deep and 7 feet in diameter, and is lined with sheet-iron. On its bottom are four tracks for small carriages carrying the gas burners. These are practically Bunsen burners on jointed pipes. One row is thrown against the interior of hoop and one against its exterior. The fuel is the ordinary city gas mixed with air driven in by a blower.

The operation of hooping is as follows: The mortar is placed in position on the truck, and its bore closed front and rear, the plugs being connected by a long rod with head on one end and nut on the other. Two holes in the front plug receive pipes, one to admit water to the bore, and the other to act as an overflow. A clamp ring (two halves) is clamped around the hoop. This is attached to the rear trolley. The hoop is then run over the pit and lowered into position. The pulley hook is detached, the gas lighted, and air admitted until the color of the flame indicates a sufficiency, when a sheet iron cover is placed over the pit. At frequent intervals the cover is removed, and a gauge rod of minimum prescribed length applied by the foreman. When the rod enters the hoop, the latter is quickly hoisted from the pit and run to near the breech of the mortar and laid on the floor. The pulleys are cast off and trolley No. 5 run to the rear. The inspector then tries his gauge, and notes the change from the prescribed minimum length. The collar is then run to the rear of the hoop, and the latter is connected with trolley No. 3, raised and entered on the mortar, and run to position. The collar is next run up in rear of the hoops. The side screws are quickly connected with it, and by means of long levers the nuts on the screws are turned so as to bring the collar against the hoop, and the latter into its position. The water ring is then run over the front end of the hoop, and the water is turned on. During the cooling the levers are frequently turned to force the hoop well forward. From the time the hoop leaves the pit to that at which it is fully in position and the water turned on, hardly more than two minutes elapse. About twenty minutes are required to heat the hoops, and nearly the same time to cool them.

Finish bore.—The mortar is finished bored in a third lathe, the arrangements for holding it being as follows: To the face-plate a flanged muzzle collar is secured by bolts through holes in flanges. The muzzle of the mortar enters the collar, while the breech rests in a semicircular support on the ways of the lathe. Heavy iron straps, having loops over the trunnions, are secured to the face-plate. This prevents the mortar from working to the rear during its rotation. Set-screws through the sides of the collar enable the muzzle to be shifted if necessary. Wedges under the rear support, connected by screws, afford means of slightly shifting the breech if required. . . .

During the finish boring kerosene oil is forced through a pipe into the interior of the reamer, which is hollow, and from which it escapes through small holes against the sides of the bore.

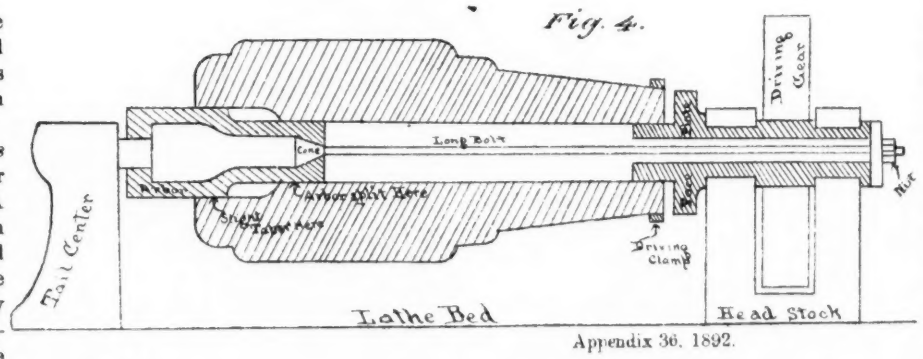
Fig. 3.



Ord 52 2

Method of Boring Straight Hole.

Fig. 4.



Appendix 36. 1892.

Method of Holding Mortar while turning exterior

Ord 52 2

Electrical Extensions in France.

After so much has been said about the possibility of electricity being used for the traction of boats upon canals, it is encouraging to find that practical effect has been given to some of the numerous suggestions made at the late Congress upon waterways by M. Galliot, Engineer of the Ponts et Chaussées, at Dijon. M. Gailiot has indeed been the first to devise and lay down an electric installation for the towing of boats. This has been done upon the Burgundy Canal, and connects the Seine with the Saône, and the installation is at work in a tunnel 3,300 m. in length, that traverses the watershed from which flow the rivers into the English Channel and the Mediterranean. Hitherto the passage has had to be made by steam tugs, which filled the tunnel with smoke, and rendered the navigation very dangerous. In order to secure the necessary power for generating the electricity, M. Galliot connected several of the locks, at each of which the water falls 2.60 m., and created a fall of 7.50 m. upon the Seine side of the watershed, and another 8 m. upon the side of the Saône. By this means he has utilized an enormous force of water, which hitherto was entirely lost, for propelling the boats, which receive the electricity by contact with an overhead wire. Both the boat and tunnel are also lighted with electricity, so that the dangers and inconveniences of the passage are entirely removed. After such a successful application of electricity, it is likely before long to be very extensively employed for the towing of boats upon the canals. In several other ways the water power formerly wasted is being turned to good account for the generating of electricity, and there is a considerable number of towns in France, notably in the Loire and in the neighborhood of the Jura Mountains, where both light and power are obtained from this source. At Lyons electric power is distributed to small users at a very low price, and a similar installation is about to be laid down at St. Etienne. Several projects are now being carried out by M. Ritter an engineer of Neufchâtel. M. Ritter, has secured a concession from the State for the use of the waters of the Loire from the source of that river for a distance of four kilometers. He proposes to obtain an enormous hydraulic power by bringing the waters from the source by means of a level canal, and in parts subterranean, to the village of Monthier, and

thus create a fall which will have a minimum force of 4,000 horse-power. This will be used for the industrial establishments in the valley of the Loire, and also for the lighting of the towns of Pontarlier and Besançon, which latter town is at a distance of 35 kiloms. from Monthier. Another utilization of hydraulic force is to be made in Switzerland, where the waters of the Doubs will supply power and light to several towns and villages in the districts of Porentruy and the Franches Montagnes. Several other projects are being put in hand by M. Ritter, who has an admirable scope for enterprise in turning to profitable account the enormous waste of hydraulic power in the Jura Mountains. One remarkable result of these undertakings is the great transfer of industrial activity from certain centers to districts in which electric power is available at little cost, and with the laying down of new installations an enormous impetus is given to the construction of manufactories, all of which are working entirely by the aid of electricity.—*The Engineer* (London).

MANUFACTURES.

Edwin Morril is about to establish a machine shop at Shawton, Me.

Lee's cutlery shops, at Northampton, Mass., have started up with increased force.

J. Doerr and L. R. Buder have incorporated the St. Louis (Mo.) Wood Pump and Pipe Company, with a capital stock of $10,000.

The American Engine Company, Bound Brook, N. J., has issued a very creditable catalogue of modern and high speed engines.

The Surbridge Manufacturing Company, Hagerstown, Md., will soon put in a hundred horse-power engine and boiler—not yet purchased.

The large machine and wire works of W. H. H. Sisum, at Belleville, N. J., has been started up, after having been shut down several months.

The Hayden & Derby Manufacturing Co., 111 Liberty street, New York, issue a neat little pamphlet descriptive of injectors and ejectors.

Soult & Co. will build new building to replace one lately burned in Frederick, Md., and equip a plant for the manufacture of wire picket fences.

At New Britain, Conn, Hopkins & Allen, whose plant has been idle for 3 months, have resumed in full with orders ahead sufficient to keep busy for some months.

Patrick J. Conley and William N. Alexander have incorporated the Fordyce (Ark.) Nut Lock Company. The capital stock is $100,000, of which $10,000 has been subscribed.

Geo. T. McLauthlin & Co., engineers and machinists, Boston, Mass., send us a neat little circular of their speed gauge, illustrated some months since in our columns.

An official of the Florida Central & Peninsula Railroad says that the company's new shops will be built in Savannah, Ga., and that work of erection will commence shortly.

The Garvin Machine Company, New York, issue a very comprehensive catalogue showing the operations that can be performed by the use of their recent universal No. 3 cutter and tool grinder.

The Piqua (O.) Iron Works has been established for the purpose of manufacturing engines and boilers, saw mills and mill work, copper and brass castings and to deal in general engineering supplies. We are informed that prospects are bright.

A Detroit (Mich.) dispatch says: Murphy, Wasey & Co.'s big chair factory resumed recently with its full force of 450 hands after having been shut down since Christmas. The Detroit Stove Works, now employing a third of the regular force, will start full blast soon.

Fair Haven [Vt.] people are interested in the announcement that the limestone quarries near there, which have lain idle for about three years, are to be opened soon. Employment will be furnished to 65 or 70 men, and 300 tons of limestone produced daily, the stone to be used in the blast furnaces at West Troy, N. Y.—*The Vermont Phœnix.*

Griffith & Nathaniel, of Poultney, one of the largest slate manufacturing firms in the State, have stopped all work at their quarries and works for an indefinite time. They are one of the oldest firms in the town, and in the best season of the year employ about 200 men, all of whom are now without work. The shut-down is due directly to the slate pool breakup January 4th.—*The Vermont Phœnix.*

The Joseph Dixon Crucible Company, Jersey City, N. J., continue their crusade in favor of pure graphite for lubricating purposes, by issuing a revised pamphlet for free distribution, relating to the subject. The experience of a large number of engineers and mechanics are given, and much other useful information. Every mechanic and engineer should read this little pamphlet and lay it away for future reference.

The Buffalo Forge Company, Buffalo, N. Y., is making a special study of heating and ventilating buildings in connection with the use of their fans. It gets pretty cold in Salt Lake City and vicinity, where several of their plants are in use, especially in school buildings, and letters we have seen from them show that their system is appreciated, not only for the uniform temperature maintained in the different rooms, but on account of the low cost of fuel.

The Lodge & Davis Machine Tool Co., of Cincinnati, O., U. S. A., have received an order from the Societe Anonyme Cockerill, Seraing, Belgium, for several of their machine tools. This concern employs 9,000 men, and is to Belgium what Krupp is to Germany. They are large contractors and builders of heavy ordnance guns, locomotives, etc., for the Belgian Government. The above order is a direct outcome of the Lodge & Davis exhibit at the World's Fair, the agent of the Cockerill Company having spent several months at Chicago, inspecting the various makes of machine tools.

Messrs. Dawson & Goodwin have opened a machine store at No. 57 South Canal street, Chicago, where they will handle a full line of machine tools, including engine lathes, drill presses, shapers, special turret lathes, pulley lathes, radial drills, milling machines, punches, shears, etc. Mr. Dawson has conducted a machine shop in Chicago for some time, and more recently has been a salesman for the Reeves Pulley Company. Mr. Goodwin has been with the Lodge & Davis Machine Tool Company for several years, having opened their Chicago store and acted as manager until a short time ago. Both have a thorough knowledge of the machine business, and know the trade.

A Nashville (Tenn.) dispatch of January 27 says: Plans have been perfected for a reorganization of the Southern Iron Company under the name of the Central Iron Company. The company made an assignment last August of its personal property in order to liquidate its floating debt. The property will be sold at Huntsville, Ala, on February 20th, by the Central Trust Company, of New York, under deed of trust executed January 1, 1890. The company defaulted in interest on its bonds and the trustee is now proceeding to foreclose under the mortgage. The property will be purchased by the owners of the security. The new company has already been chartered under the laws of Alabama. The stock and bond issue under the plan of reorganization will be cut from $7,000,000 to about $5,000,000. The company owns seven furnaces in Tennessee and Alabama and about 150,000 acres of valuable ore and timber lands.

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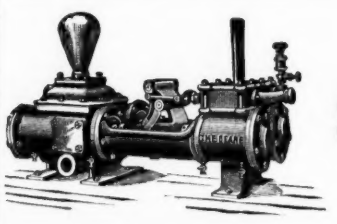

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A special Raleigh (N. C.) dispatch to the *Evening Post*, dated January 30th, says: A contract has been signed by which the Lobdell Car-wheel Works, of Wilmington, Del., will build and operate a large car wheel factory in Raleigh. Arrangements have also been made with the Johnston Axle Company by which axles will be furnished to the Raleigh wheel factory. There is already a large car and coach plant in operation in this city, and by these new arrangements cars can be made here as cheaply as in any place in the country. The Great Falls Manufacturing Company, composed of ex-Senator William Mahone and several New York capitalists who recently invested largely in the water-power near Weldon, N. C., seem to be in earnest about developing their property. An avenue three miles long has been cut from Great Falls to the Raleigh & Gaston Railroad, and a site for a village is being laid off. A number of cotton and wood-working and other factories will be built there at once.

Machinists' Supplies and Iron.

NEW YORK, February 10, 1894.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $13.00 to $14.00; No. 2, $12.50 to $13.25; Gray Forge, $11.75 to $12.50. Southern brands of good quality are obtainable at $13.00 to $14.00 for No. 1 Foundry; $11.75 to $12.50 for No. 2, and $10.75 to $11.25 for Gray Forge.

Antimony—The market is steady and quiet. We quote L. X., 9.30c. to 9.40c.; Cookson's, 10c. to 10½c.; Hallett's, 8.90c. to 9c., and U. S. French Star, 10c.

Lard Oil—Prime is quoted at 67c. to 68c.

Copper—The market is dull. Lake Copper is quoted at 9⅝c. to 9¾c. Casting Copper is held at 9¼c. to 9⅜c.

Lead—The market is quiet, but steady at 3.15c.

Spelter—The market is decidedly more active, and quotations have advanced. Sellers are asking 3.85c for prompt delivery, bids range from 3.72½c. to 3.95c., according to delivery.

Tin—The market is lower, and the demand restricted to immediate wants. The general quotation is 19.70c. for prompt delivery, but it is reported that private business has been done at less.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Foremanship by one of exp.; engines, pumps, or gen. repairing. Indicator, AM. MACH.

An experienced foreman pattern maker wants sit'n; highest refs. as to ability. Patterns, AM. MACH.

Comp. draftsman exp'd in eng., boilers and general mach. wants position. Box 3, AM. MACHINIST.

Tool maker, 33, dies, tools and punches, wants position. Box 8, AMERICAN MACHINIST.

Mechanical and iron ship draftsman wants steady employment, moderate wages. R., AM. MACH.

Draftsman, technically trained, 2½ years' mach. shop exp., wants position. Box 17, AM. MACHINIST.

Experienced mechanical draftsman, Swede, graduate, esires position; best refs.; steam engines preferred, moderate terms. G., AMERICAN MACHINIST.

Mech. draftsman, grad., with 10 years exp., desires position; iron and steel works preferable. Refs. A1. Address Box 15, AMERICAN MACHINIST.

Wanted—Position by first-class draftsman, also a machinist; is competent to take charge. Address R. L., AMERICAN MACHINIST.

Wanted—Situation by expert all-round machinist as foreman, assistant or first-class machinist; Southern or Western States preferred. John T. Usher, Box 10, AMERICAN MACHINIST.

Desires a change, open for engagement as foundry foreman, reference may be had from present employer; 170 have been under my charge at one time. Address Box 14, AMERICAN MACHINIST.

Wanted—Situation by a first class machinist, experienced in manufacture of steam engines, pumps, and special machinery; four years as foreman; references. Address Box 16, AMERICAN MACHINIST.

Asst foreman boiler maker, locomotive works, age 35, thorough mechanical, make estimates, wants position as foreman, or contract to build or rebuild boilers, tanks, reset tubes, etc.; R. R. shop pref'd; refs. A1. "Temperate," AM. MACHINIST.

Wanted—Foreman for erecting and machine shop by a pump company manufacturing steam pumps. A good opening for a young man of energy and experience. State age, experience, and references. Address B., AMERICAN MACHINIST.

Open to engagement, a thoroughly pract. and theoretical mech. & hydraulic engineer; designer of hydr. plants a specialty; expert in the mfg. of seamless steel tubing, drawn steel articles, hot or cold, and hydr. forgings; ref. Box 9, AM. MACHINIST.

Wanted—Situation as foreman or superintendent of machine shops; have held both positions; experienced on Corliss engines, mining & gen. mach'y; 38 years of age; 22 years' practical experience; first-class references. Address Box 4, AM. MACHINIST.

(*Continued on page* 14.)

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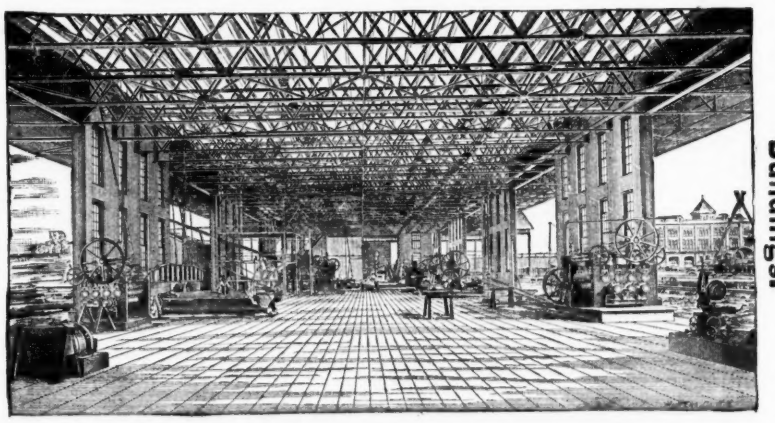
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of Iron and Steel Bridges and Buildings.



The above illustration is taken direct from a photograph, and shows the interior of the first floor of a Ship Shed designed and built by us for The Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 60 feet in width by 320 feet in length—with an overhang 12 feet wide on the outside entirely around the building. The door openings are every 40 feet and are made 40 feet wide, so that teams can drive in and out for taking in the raw material and bringing out the finished product.

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14-inch Engine Lathe.

THE CELEBRATED
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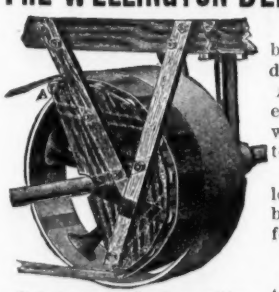
METAL-WORKING MACHINES
FITCHBURG,
MASS.

THE WELLINGTON BELT HOLDER.



Large or small belts shifted from driving pulley and held at rest, and easily slipped back when machine is to be started.

It dispenses with loose pulleys, saves belts, and is perfectly safe.

It is *cheap*.

Write for descriptive circular and price list to

Cut shows holder in position beside driving pulley.

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in the pattern room will save its cost EVERY 60 days.

OVER 7,000 SOLD.

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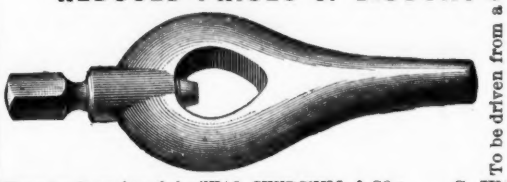

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9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

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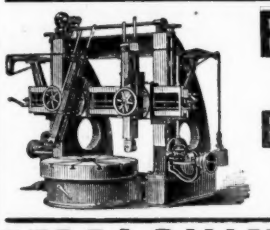

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For Reducing and Pointing Wire.
ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.
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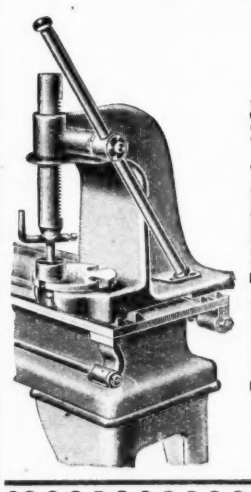

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"Star" Foot Lathe Swings 9x25 in.
LATHE
Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers.
Catalogue Free of all our Machinery.
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ROPER'S PRACTICAL HAND BOOKS,
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These books embrace all branches of Steam Engineering—Stationary, Locomotive, Fire, and Marine. Any Engineer who wishes to be well informed in all the duties of his calling should provide himself with a full set. They are the only books of the kind ever published in this country, and they are so plain that any Engineer or Fireman that can read can easily understand them.
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64-page Pamphlet containing Description of Meter, Rowland Prize Paper, by Clemens Herschel (the patentee), and Records of Tests of 36-inch and 48-inch Meters
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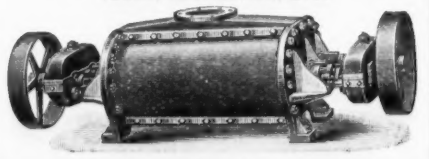
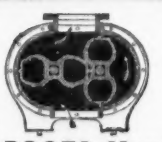
For FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.



SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.



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FOR
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COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
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ST. LOUIS, DENVER.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

A designing engineer and draftsman with wide exp. on multi cylinder Corliss high-speed, direct-connected electric engines heavy hoisting and mining engines and mach'y, air compressors, etc., desires a pos of trust and responsibility; highest references. Box 18, AMERICAN MACHINIST.

A well-educated mechanical engineer whose experience covers an extensive practice in engineering, manufac'g, etc., & whose qualifications are of the highest, desires engagement as manager, supt., or other responsible position; location no object. A. M., Box, 589, Ravenswood P. O., Chicago, Ill.

Wanted—First-class machinist, who has had practical experience in designing and making tools for a milled machine screw factory; rising young man preferred; must be temperate, reliable, and well recommended; state salary, experience, age, etc., John Morrow Machine Screw Co., Ingersoll, Ont., Canada.

MISCELLANEOUS WANTS

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa

For Sale—Second-hand drill presses, engine lathes & planers. Dietz. Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Calipers, Surface Gauges, etc. Catalogue free. Send for it. F. A. Welles, Milwaukee, Wis.

Wanted—Patterns to make. Estimates made on application to Wattles Gas Eng. Co., Elizabeth, N. J.

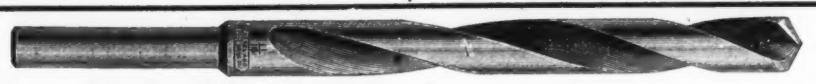
Wanted to arrange with some responsible manufacturing concern to put on the market a new gas engine which is entirely novel in gas engine practice. Box 13, AMERICAN MACHINIST.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

We will pay 50 cents each for copies of the AMERICAN MACHINIST of December 4, 1886 issue; must be unsoiled and in good condition. AMERICAN MACHINIST PUBLISHING COMPANY, 203 Broadway, New York.

Wanted—Steam engine 15 to 20 h.-p., and boiler of 20 h.-p., also dynamo for 130 incandescent and 30 arc lamps; also 30 arc lamps with 15 rheostats, one voltmeter and one amperemeter. A complete plant, second-hand preferred; give full description and prices. J. B., AMERICAN MACHINIST.

Michigan Agricultural College offers instruction in mechanical engineering—four years' course; the average expense of attendance at the college is $135 per year; the course is arranged so as to give students an opportunity to earn a portion of their expenses. Address Mechanical Department, Agricultural College P. O., Mich.



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BOILER TOOLS and STEAM HAMMERS.

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" " 16 " x 8 " Ames "Reverse Motion."
" " 16 " x 7 " Bridgeport. Good order.
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" " 20 " x 10 " Putnam. A1 order.
" " 24 " x 12 " Fitchburg. A1 order.
" " 36 " x 14 " Heavy pattern. A1 order.
Planer, 19 in. wide x 3 ft. long. Wheeler. Good order.
" 24 " x 5 " New Haven. Good order.
" 24 " x 6 " Wood. Light. Good order.
" 30 " x 8 " Whitcomb. Good order.
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" Gang. 3 Spindle. Garvin. Good order.
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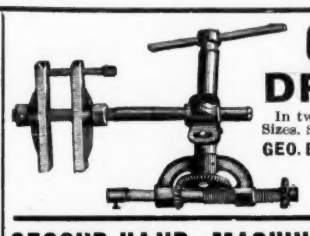

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3 10 " Garvin.
3 12 " "
1 10 " Reed.
3 20 " x 8 ft. Ames Mfg. Co.
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2 22 in. x 8 ft. Ames Mfg. Co.

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1 " " Lodge & Davis.
1 " " Hendey Machine Co.

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1 No. 1½ Garvin.
1 " 5 Brainerd.
1 " 2 Garvin.
4 " 1 Pratt & W. Lincoln.
2 F. E. Reed Lincoln.
1 No. 4 Garvin. Rack Feed.
1 Merritt Heavy Back Geared.
No. 3 Brainerd Standard Universal.

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2 No. 00 Garvin, W. F.
1 " 1 " "
2 " 2 " "
1 No. 2 Brown & Sharpe.
1 " 3 " "
1 " 5 " "

POWER PRESSES.

1 Small Camfee.
1 No. 3 Eaton.
1 " 18 Bliss.
1 " 2 Stiles.
1 " 3 "
1 " 6 Niagara.
1 " 21 Bliss.
1 " 53 "
1 " 36 "
2 " 7 " Heavy Drop.
1 " 7 " Foot Press.

MISCELLANEOUS.

2 No. 1 Garvin Gear Cutter.
1 4 in. Curtis Pipe Machine.
1 2 " Bignal & K. Pipe Machine.
1 No. 3 Diamond Grinder.
3 " 2 " "
1 " 2 Garvin Cutter Grinder.
2 Garvin Screw Slotters.
2 No. 2 Brown & S. Tappers.
1 6 in. Bement Slotter.
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1 " " " Double " "

Also, large number of other machines. Write for complete list and detail description.

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COMBINATION CHUCKS

SIMPLE, STRONG, TRUE; WITH OR WITHOUT REVERSIBLE JAWS.

Standard Independent, SOLID Shell, Solid Reversible Jaws.

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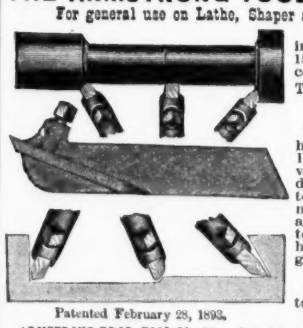
Send for Illustrated Catalogue and Price List.

THE ARMSTRONG TOOL HOLDER.

For general use on Lathe, Shaper and Planer.



Over 10,000 already in use. Have sold 150 tools to one concern.

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I have used the tool holder you sent, and I must say that I was very much prejudiced against most tool holders in the market, but I am agreeably surprised to find that these have turned out good. R. PERKINS, Gen'l Mgr.

Let us send you a tool on trial. Send for circulars.

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CHAS. CHURCHILL & CO., London, Eng., Agents.

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Endorsed by Practical Mechanics Everywhere. Send for Catalogue.

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The Simplest Ever Made.
Send for Catalogue.

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General Agents Wanted.

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93 in. Hydraulic Riveting Machine, Pump and Accumulator.
10 Ton Crane Bridge, 24 ft. x 20 ft.
Plate Planer, 16½ ft., one setting. 1 in. Plate.
Shear No. 27, 30 in. throat, ¾ in. plate.
Above entirely New, made by Bement, Miles & Co.

— ALSO —

Boiler Rolls, 8 ft. 3 in between Housing. Cheap.
Punch, 21 in. throat. Teal.
60 in. Swing Post Drill. Hilles & Jones.
Full Line Lathes, Planers, Drills, Milling Machines.
Screw Machines, Shapers, Profiling Machines, etc.
No. 3 Stiles Press.
Lot of **Polishing Machinery, Dynamo** for Electro-plating, Drop Hammer, Belting, etc., etc.

Send for December List of Machinery on Hand.

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Warehouse: 511 and 513 WEST 13th STREET.
Office: 120 BROADWAY, NEW YORK.

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GROBET SWISS FILES.

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FOR SALE.

An iron building, lately used as a Glass Works, now standing at Lenoxdale, Mass., same being 18 ft. height of post, by 80 ft in width. by 300 ft. in length. Same will be sold for but little more than the price of scrap iron, either as a whole, or in parts to suit, taken down and loaded on cars complete, ready for erection. Price and further particulars upon application to

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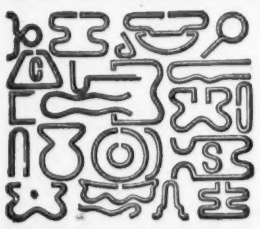
Chicago: 902 Masonic Temple. Philadelphia: 119 S. Fourth Street. Cincinnati: 34 West Third Street. Boston: 19 Milk Street. New York: 278 and 280 Broadway. Pittsburgh: 121 Third Avenue.



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Builders of WIRE FORMING MACHINES

With F. B. Manville's Patent Sliding Former.

For making articles from the coil, of either round, half round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.

Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.

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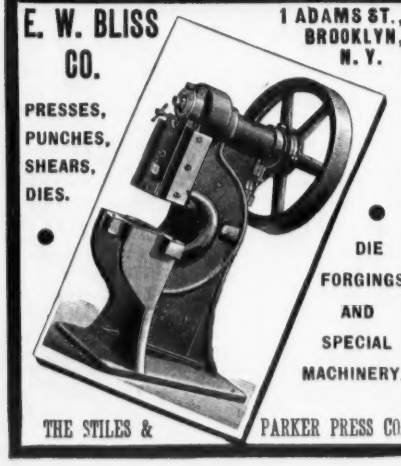

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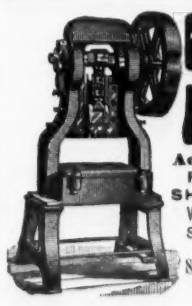

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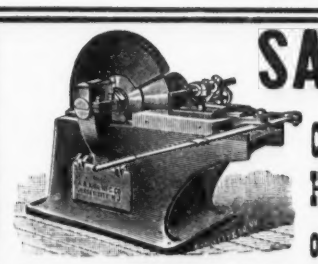

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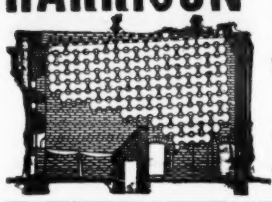

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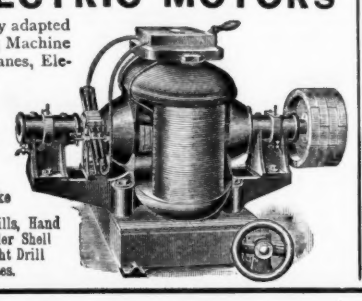

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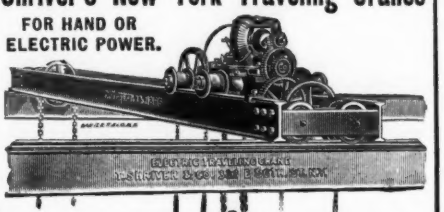

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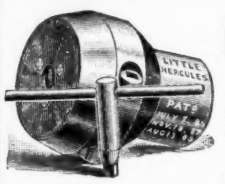

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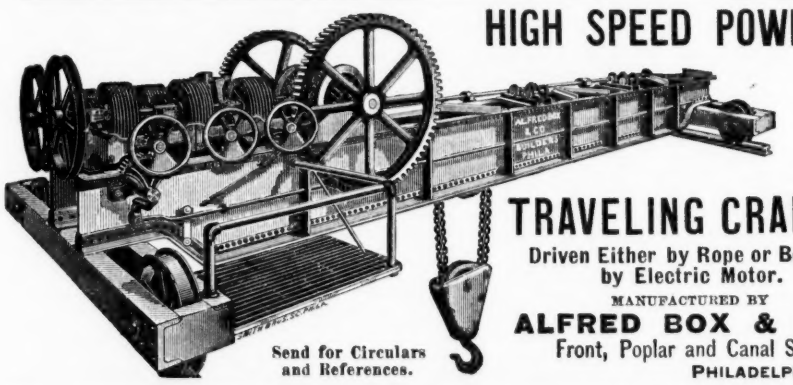

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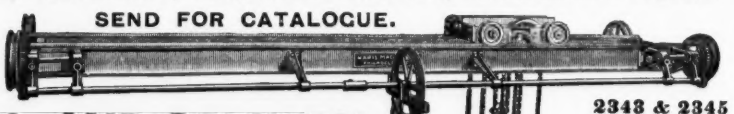

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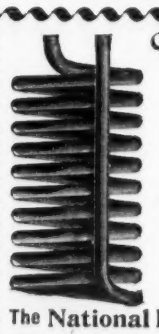

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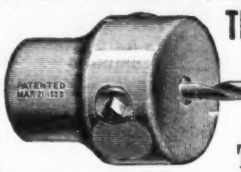

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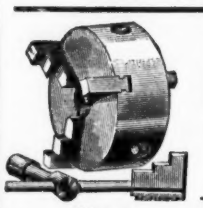

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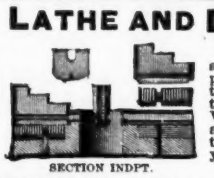

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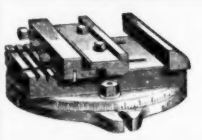

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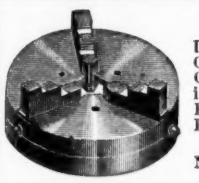

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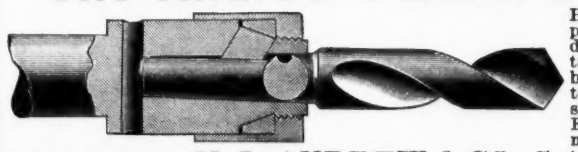

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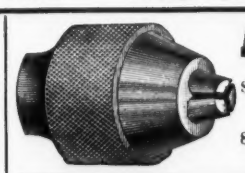

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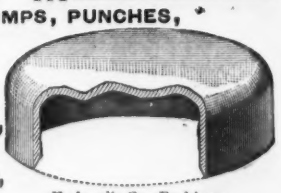

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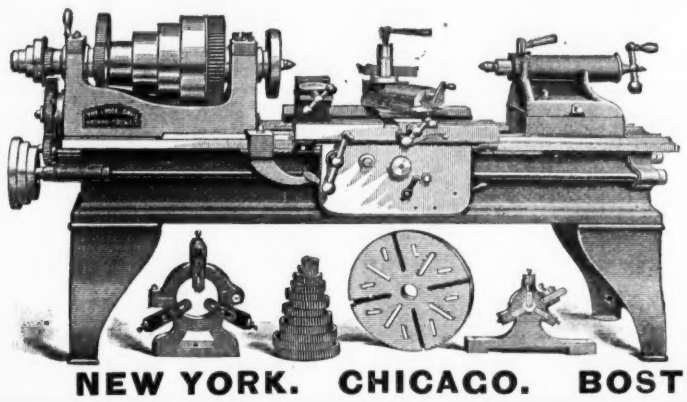

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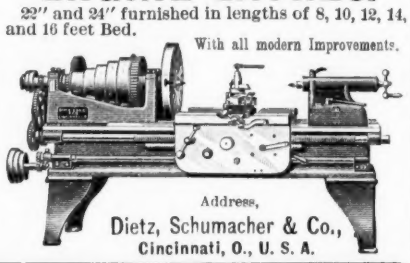

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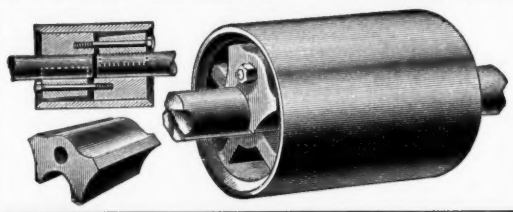

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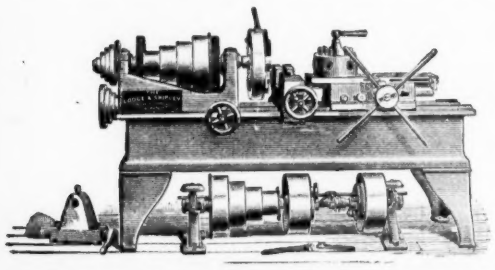

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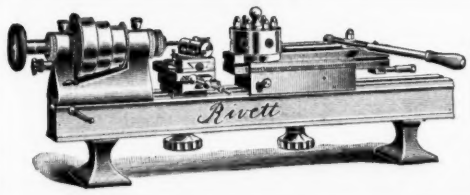

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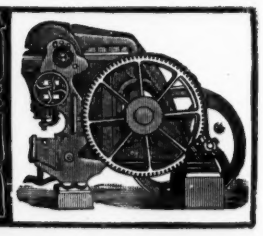

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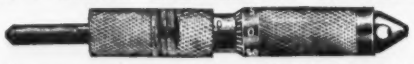

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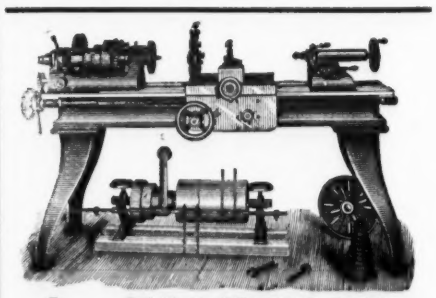

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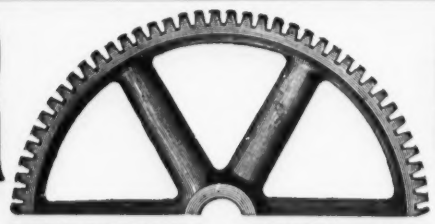

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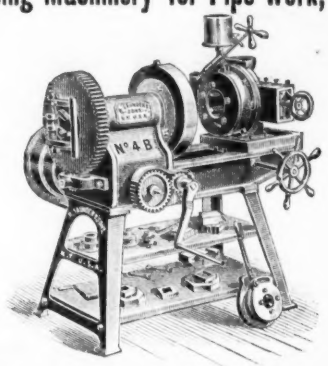

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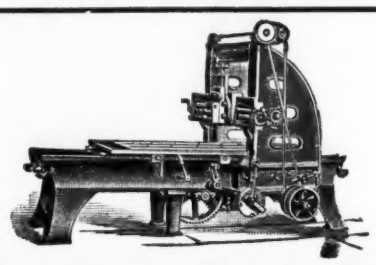

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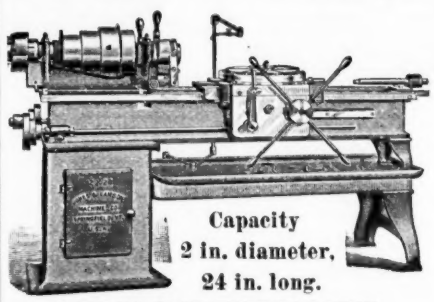

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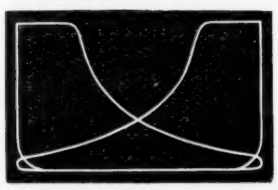

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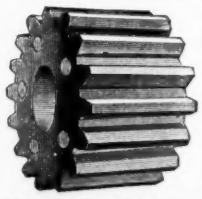

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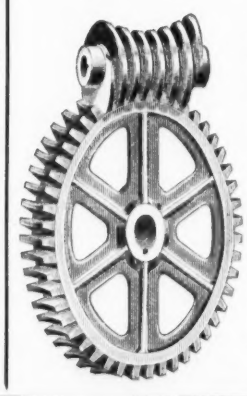

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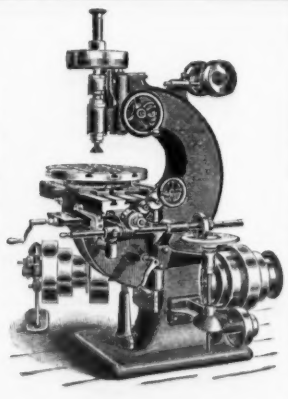

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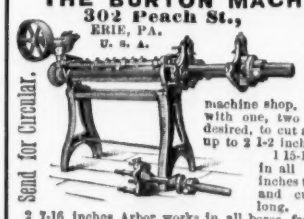

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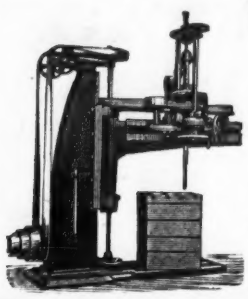

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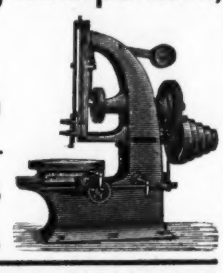

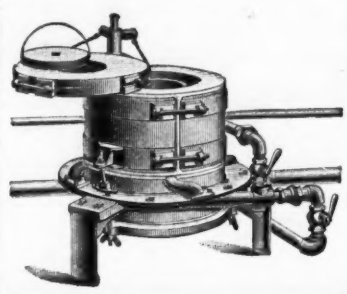

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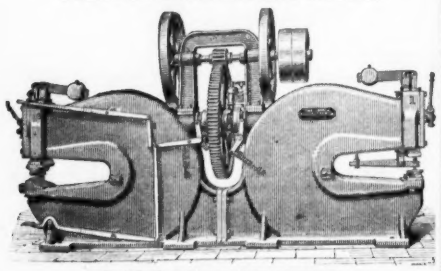

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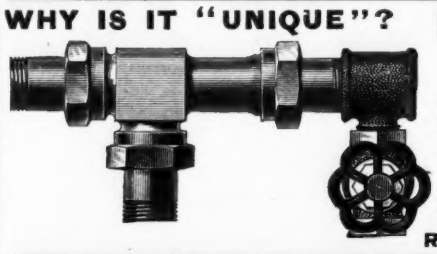

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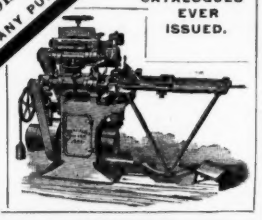

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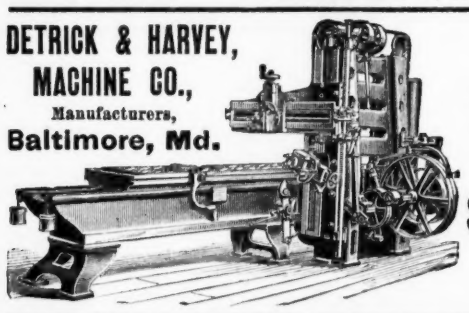

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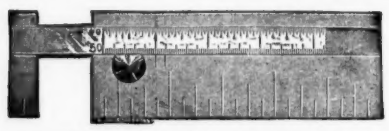

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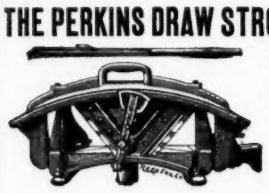

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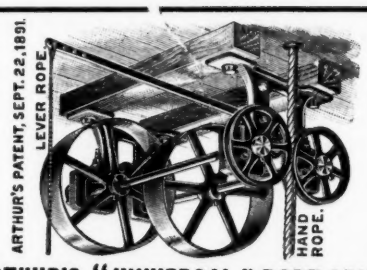

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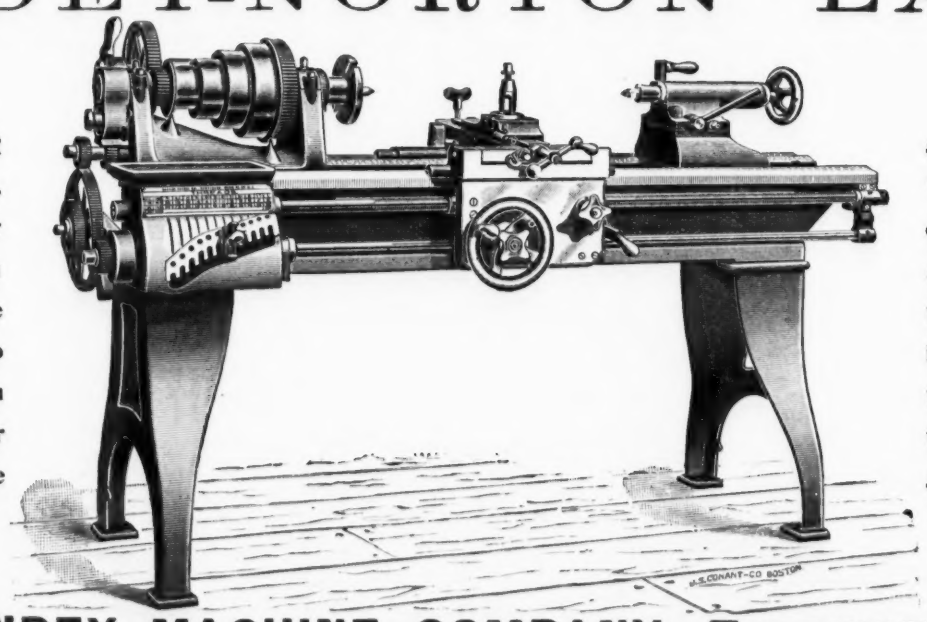

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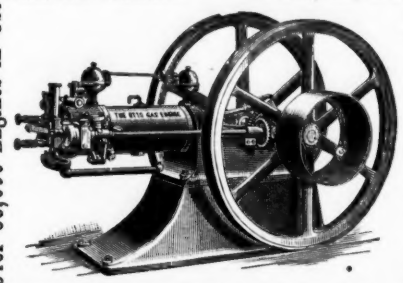

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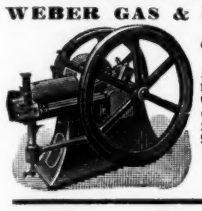

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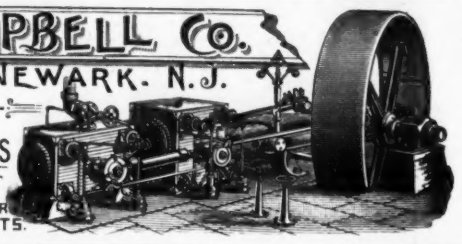

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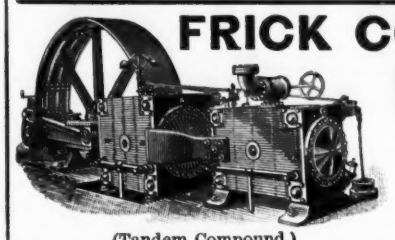

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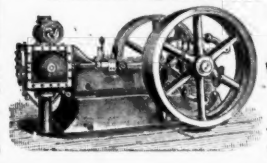

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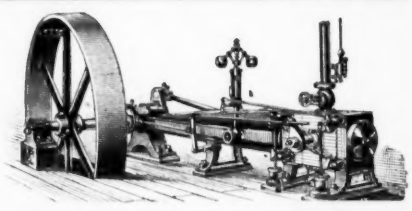

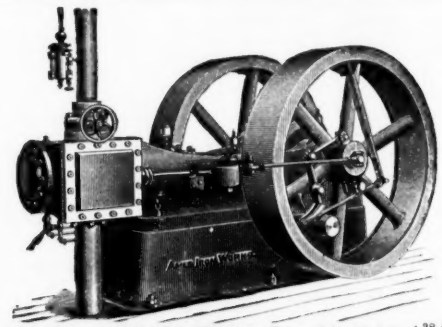

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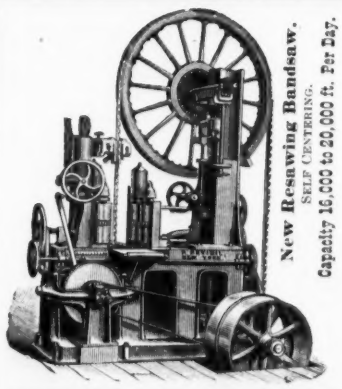

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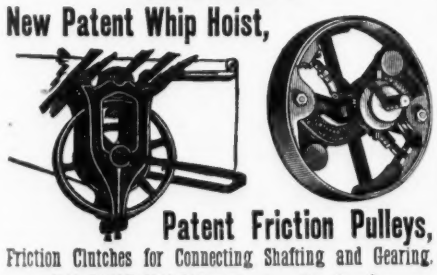

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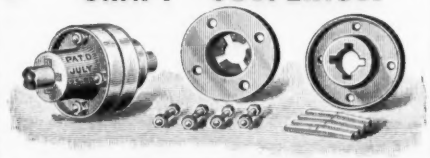

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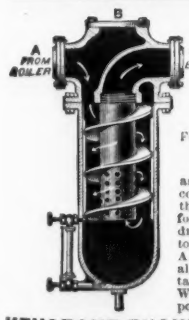

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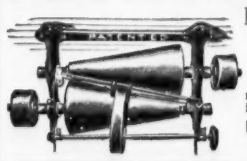

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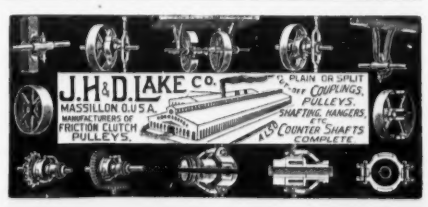
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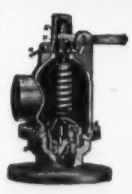

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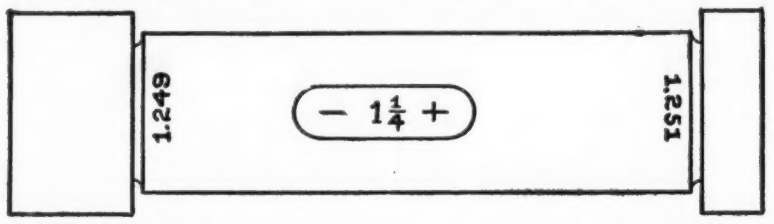

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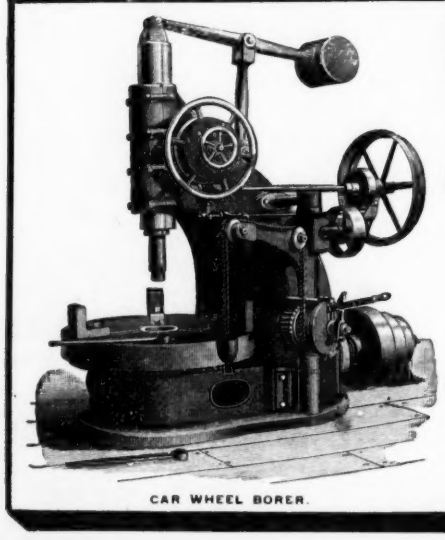

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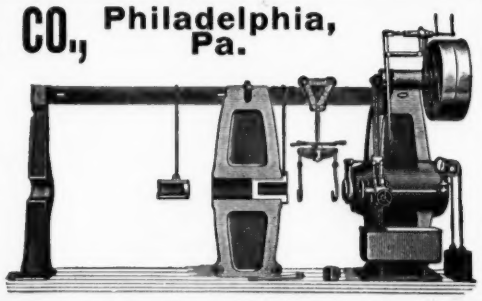

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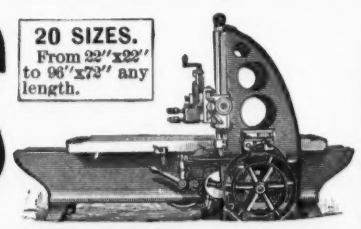

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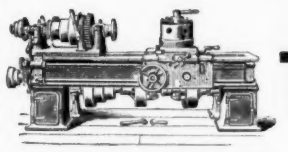

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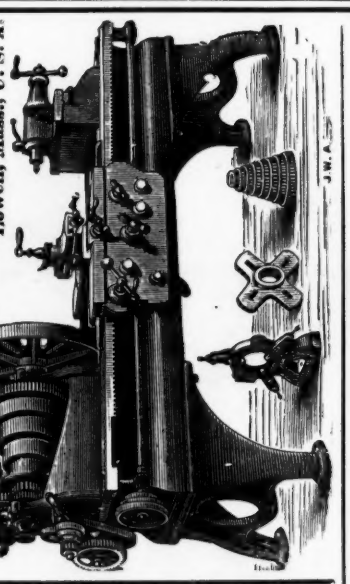

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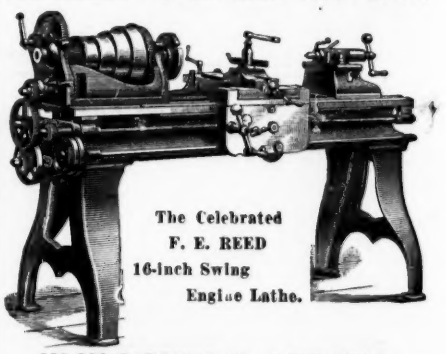

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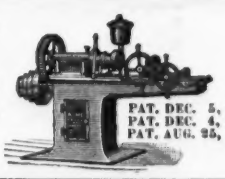

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